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AVIATION

The Oldest American Aeronautical Magazine

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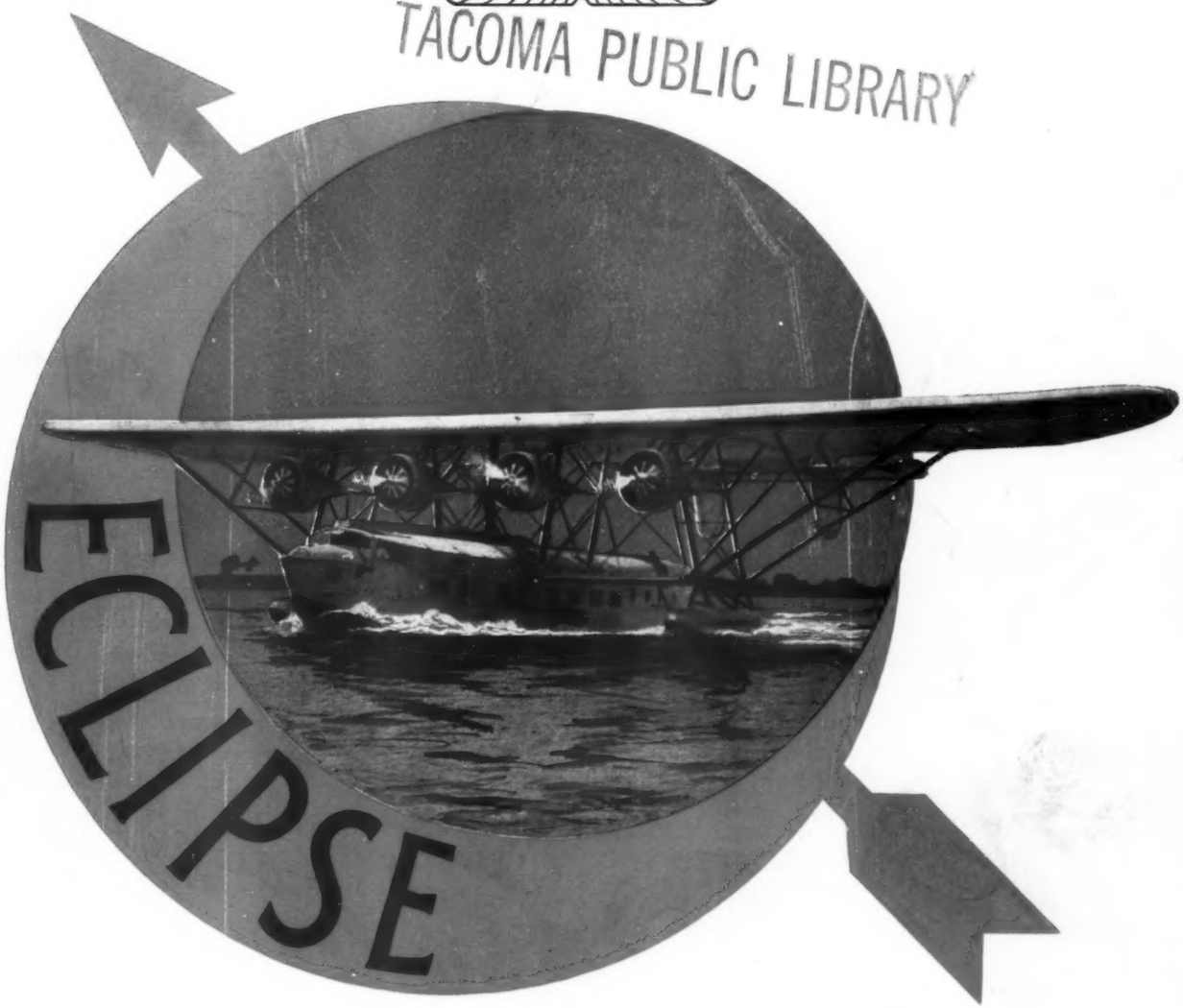

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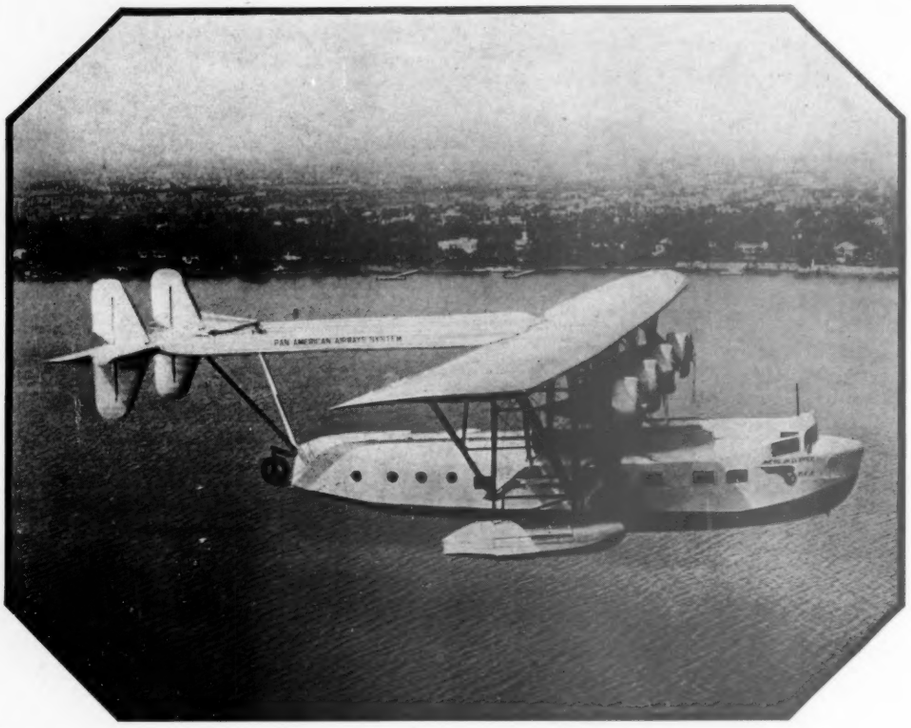

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AVIATION

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The Oldest American Aeronautical Magazine

EDWARD P. WARNER, *Editor*

LOUIS F. STOLL, *Publishing Director*

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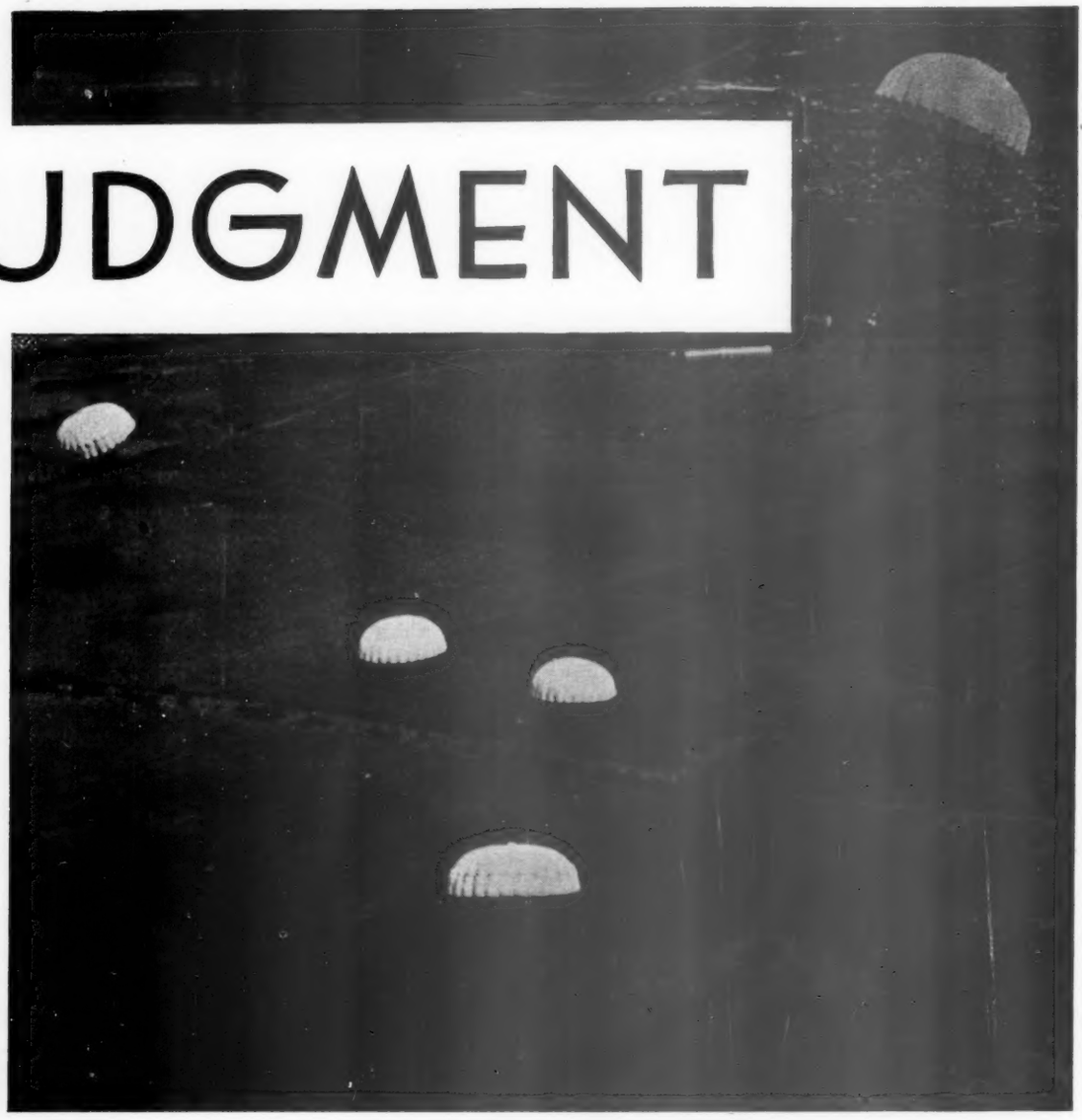

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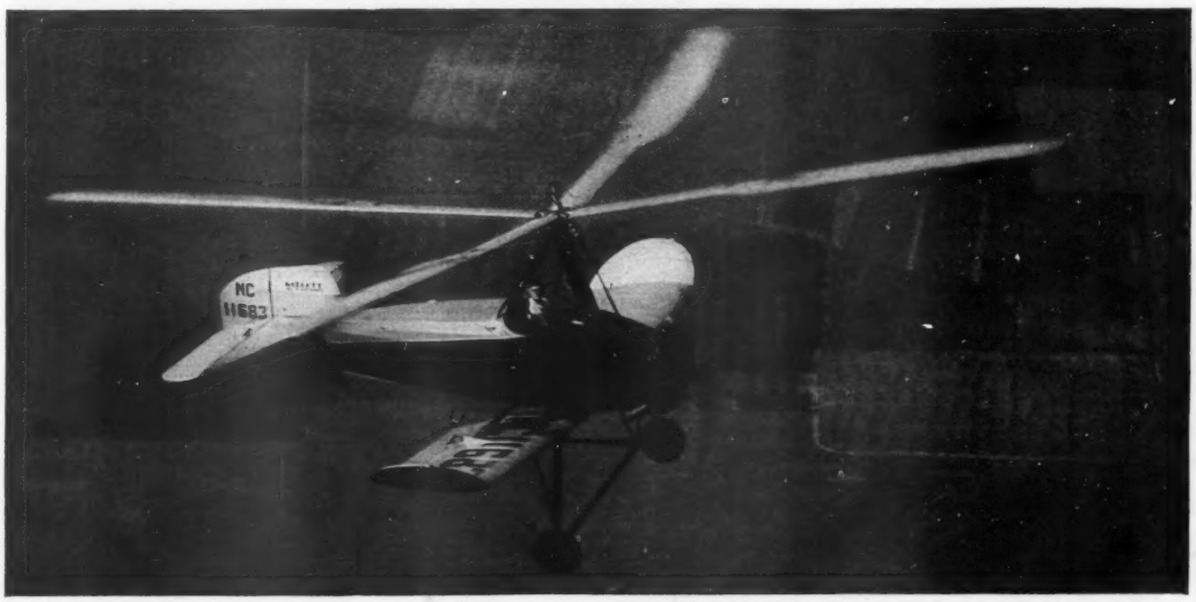

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To appreciate the fundamental distinction between the airplane and the Autogiro it is necessary first to understand the essential theory of flight of any heavier-than-air craft.

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Air is a fluid, but of such thin consistency that, when still, it cannot support even the lightest feather.

However, move air rapidly or move an object rapidly through it, and air becomes "resistant" and affords "support."

Stripped of technical details, that is why all heavier-than-air craft can only be sustained in flight by rapid movement of their lifting surfaces through the air. Since the airplane's lifting surface (fixed wings) are a fixed part of the machine itself, their movement through the air is solely dependent upon the fast forward speed of the entire machine.

On the other hand, the speed of the fast moving lifting surfaces of the Autogiro (its rotor blades) is independent of the speed of the craft itself. Therefore the Autogiro is capable of sustained flight with very little forward speed of the machine as a whole.

To this one all-important difference is traceable all the Autogiro's distinctive characteristics, including its immunity to spins and other critical situations, its ease of control and maneuverability.

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THE LION'S SHARE . . . AND KENDALL

John Livingston, President of the Mid-West Airways Corporation, and his Monocoupe No. 14.

Possibly those who saw or read of the 1931 National Air Races thought that John Livingston and his Monocoupe No. 14 overdid things a little by walking off—or flying off—with 13 prizes, including 9 first and 3 second. But when a fast plane and a skillful pilot join with Kendall Oil, victory becomes a matter of course.

A letter from Mr. Livingston gives his unqualified views on Kendall lubrication:

"Although I have been using Kendall Oil for the past three years in my racing activities, which is certainly evidence of my high opinion of your product, I want to take this opportunity to advise you that it was again used in my Monocoupe at this year's National Air Races with the usual satisfactory results.

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John Livingston's Achievements at the 1931 Air Races

Event # 5	Men's 510 Cu. In. Free for All	First Place
Event # 6	Men's 510 Cu. In. A.T.C. Race	First Place
Event # 7	Men's 650 Cu. In. Free for All	First Place
Event # 8	Men's 650 Cu. In. A.T.C. Race	First Place
Event # 9	Men's 800 Cu. In. Free for All	Second Place
Event #10	Men's 800 Cu. In. A.T.C. Race	First Place
Event #11	Men's 1000 Cu. In. Free for All	Fifth Place
Event #12	Men's 1000 Cu. In. A.T.C. Race	Second Place
Event #14	Men's 1200 Cu. In. A.T.C. Race	First Place
Event #34	Spot Landing Contest	3 First—1 Second Places

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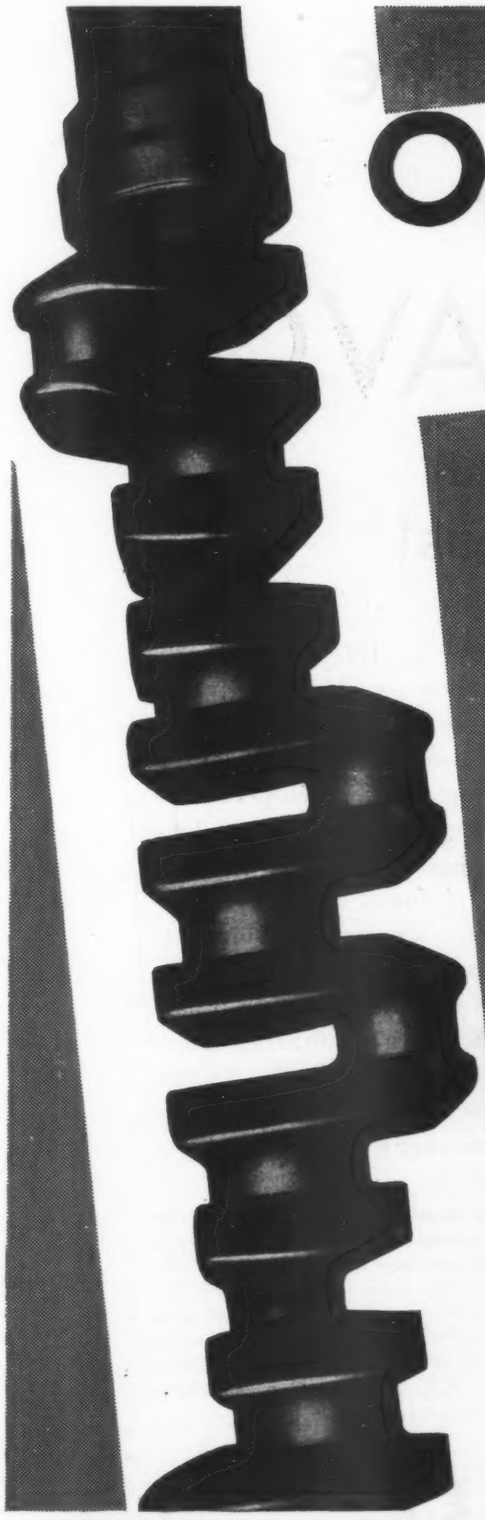

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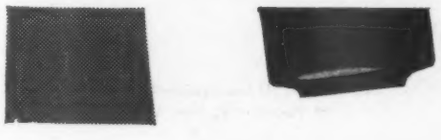

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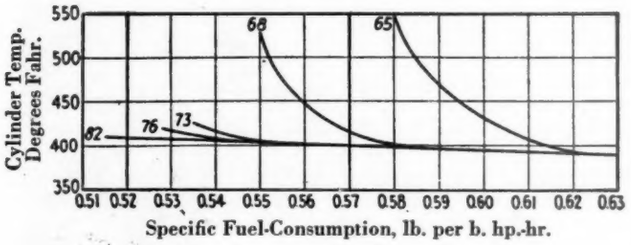

Look at the chart above—a graphic record of independent experimental tests made by a leading aviation engine manufacturer. The curve at the right was made using an automobile-type gasoline —octane number 65. The engine used .58 lbs. of fuel per brake horsepower-hour. The cylinder temperature ran dangerously high, 550° Fahrenheit!

Look at the curve farthest to the left, made in the same engine with a fuel of 82 octane number. The engine in this case used only .51 lbs. of fuel per horsepower-hour. The cylinder temperatures were *never more than* 410° Fahrenheit.

That's quite a difference—worth considering when you buy gasoline—worth money in actual fuel saved. It's worth money also in lower maintenance costs for lower cylinder temperatures mean smoother operation, better lubrication, and longer engine life.

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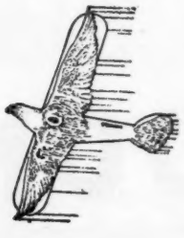
The manufacturer of your engine has approved Stanavo products. He can tell you the grade of fuel to use, or the Stanavo distributor will be glad to consult with you.

The Stanavo Specification Board has adopted the Army and Navy practice of testing aviation fuels at 300° F. jacket temperature in the Ethyl Gasoline Corporation Series 30 engine at 600 r.p.m. and 15° spark advance. As anti-knock value decreases with increased cylinder temperatures, this is a more exacting test for aviation fuels than the standard adopted by the S. A. E. for automotive fuels where the jacket temperature is 212° F.



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The Oldest American Aeronautical Magazine

EDWARD P. WARNER, *Editor*

Volume 30 . . *December, 1931* . . Number 12

Breakers ahead!

ANOTHER investigation is pending in Washington. Representative Wood, Chairman of the Appropriations Committee in the last Congress and one of the House's most persistent and experienced inquisitors, is organizing his special committee on air mail and ocean mail contracts. It is too early to say what the mood of the committee may be, but it is already painfully clear that the air mail contractors are getting a very bad press. About a year ago one of the most influential papers in the United States made a violent attack on the whole system of awarding air mail contracts, and on what it alleged to be personal favoritism in the awards. Within the past four months two of the greatest newspaper chains have independently waged campaigns of a similar order, each in a series of articles designed to prove undue concentration of contract awards and the existence of a sinister octopus in the air transport field, reaching out its tentacles to crush any independent effort.

Since AVIATION was founded, there have been more than a score of governmental investigations of various sorts in the aeronautical field. A select few of them have been very helpful, both in instructing public opinion and in pointing out our own errors and possibilities for improvement. As a general rule, however, they have served only to arouse general suspicion, to create a lot of excitement, and to permit a spectacular examiner to occupy the limelight for a time, with little resultant profit either to the aircraft interests or to the American people.

It would be foolish to waste space lamenting the burdens and the possible evil results of an inquiry to which we are already committed. We are going to have it. It now rests largely with us to say what the outcome shall be. We feel entitled to rely upon Congressman Wood's intention to make it a thorough and reasonable examination into the facts. We can face that with equanimity, and we must cooperate in it loyally, although investigations are always a disturbing and time-consuming process at best. But if two or more groups among the air transport operators go before the committee with the object of cutting each other's throats, the results may prove to be absolutely disastrous.

We have often enough opposed the action of the Postmaster General in handling the air mail. We particularly regret the intention that the Post Office Department sometimes manifests of controlling every item of activity and every operation practice. In special application to the situation that has brought about the present hearing, we feel very strongly that Mr. Brown has been unduly ready to extend his own powers under the "extension clauses" of the Watres Act, and that one of the major purposes that Congress had in mind in enacting that measure has often been lost from view in consequence.

Nevertheless the fact remains that the so-called independent operators upon whose grievances so much attention is focussed, came into the business without

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any air mail contracts and without the assurance of getting any. Some of them have proclaimed that they have no desire for government support, and that they would be quite unwilling to do business with the Post Office Department under existing conditions. Others had definite reason to aspire to contracts on certain definite routes, and were naturally and in some cases more or less justly disappointed when they failed to receive them. Still others entertained a somewhat vague idea that the Powers at Washington had assumed the responsibility for supporting any sort of an air transport line that might be brought into existence anywhere. Taken as a whole, however, they were built up as passenger lines, they were organized to be self-supporting on passenger traffic, and they have gone ahead with great courage and in most cases with high efficiency to develop their passenger business without governmental intervention. We may applaud their initiative, and admire their success and hope that it will grow, without feeling that their existence provides any adequate reason for an immediate re-distribution of air mail business or for laying heavy legal or economic penalties on the present holders of air mail contracts.

The air mail contract, both under the original Kelly Act and under the Watres Act which succeeded it, has constituted a frank subvention to a limited group of companies. Taken as a whole, they are the companies that started when the future of air transport was very uncertain and when there was no passenger traffic. All of the present air mail contractors were doing business by the middle of 1929, most of them by the early part of 1927. They were given special treatment which, for obvious reasons of economy, could not be extended to all comers. Having been on hand early, they became the beneficiaries of the government's deliberate effort to promote the formation of an air transport system. The end of the period within which such special treatment is either necessary or proper is approaching. We have previously expressed, and we repeat, the belief that within three years air transport can be upon a self-supporting basis. We prophesied a year ago, and we repeat the forecast now, that the actual net cost to the government of the air mail, or the Post Office deficit upon that heading, would attain its absolute all-time maximum in the present fiscal year, and that from now on it would steadily and rapidly decrease. In another five years it should be possible either to let all air mail contracts by competitive bidding or to distribute them arbitrarily at fixed compensations among all the operators prepared to maintain a required standard of service.

Sometime between 1934 and 1937, in short, we should be ready for a general re-deal. In the meantime, the public confidence is a factor of the first importance. It is, in fact, the one predominant factor in the development of air transport.

There lies the real danger in the forthcoming examination into the situation by the Wood's committee. It is relatively unimportant that the managers of all lines will have to devote their time to collecting evidence and presenting it in Washington. It is relatively unimportant that the committee may find occasion to pass censure upon some points of Post Office Department policy. But it is vitally important that public confidence may be disturbed. If two or more factions among the transport operators go to the Capitol and attack each other's legal status, financial stability, manners, motives, or efficiency, the aircraft industry may possibly learn something of advantage from the melee, but the non-aeronautical public will get from the headlines simply a vague general impression that something is radically wrong with American air transport. All groups will thereupon lose customers.

When Alexander Hamilton, arguing for the adoption of the Federal Constitution by the states, enumerated the dangers that confronted this people in their embarkation upon the treacherous seas of democratic government, he placed the development of passionate factional disputes among the foremost of the hazards. We shall do well to apply his warnings to our own case, for we are in no position to afford the luxury of violent and public conflict within our own ranks. The aircraft industry and the air transport operators, like the federal union, must stand united, or we may not stand at all. If the hearings of the Wood committee resolve themselves, as certain interests in Congress and out appear to intend they shall, into a war between the "pioneer operators" and the "independents," it will be a war in which everyone will lose.

Samuel W. Stratton

WHEN President Wilson appointed the membership of the newly organized National Advisory Committee for Aeronautics fifteen years ago, the director of the Bureau of Standards naturally found a place upon the list. Under the direction of the late Dr. Stratton, its head since its formation in 1901, the Bureau was already beginning those researches into aeronautical instruments and materials and power plants and equipment which have been prosecuted with such immense profit to the aeronautical world ever since. Through the five years that followed, in the difficult period of war expansion and the almost equally difficult era of post-war deflation, Dr. Stratton led that work. He was backed by as competent and as enthusiastic and as fervently loyal a group of associates as any director of a scientific institution ever had, but his leadership was never in doubt.

From twenty years at the Bureau of Standards Dr. Stratton turned to the educational field. He assumed the presidency of the Massachusetts Institute of Technology, and so the general direction of its aeronautical department, the oldest in the United States in terms of continuous activity. He entertained a firm and

undeviating conviction that it was of the greatest importance to American people that pure science should be developed to their service and that engineers should be trained to an appreciation of research. Nowhere is a constant reminder of those matters more important than in aviation. The aeronautical department was the subject of his constant interest and unvarying support and inspiration.

Whatever his other activities of the moment might be, Dr. Stratton never abandoned the interest in aeronautical science that had been formed at the Bureau of Standards before the War. He remained a member of the National Advisory Committee for Aeronautics up to the time of his death last month, chairman of its power plant sub-committee and an active participant in its meetings. Very few among the thousands of men now active in American aeronautics are ever conscious of owing him a debt, but he did more to make their work possible and to set it upon a sound scientific and economic footing than many a better-advertised figure. The support of private efforts in the development of a product by governmental research has come to be of the greatest importance in many industries in the past twenty years. Nowhere is it of more importance than in aviation, where indeed it has been absolutely vital. When the history of the government's cooperation with industry is written, Samuel W. Stratton will be recorded as first among its pioneers.

Buying military airplanes

TWENTY MILLION dollars will not stretch. What the Army and Navy can get in the way of flying equipment is finally limited by the appropriations that the Budget and Congress allow them. With the best will in the world, the military and naval authorities cannot get more out of the appropriations than there is in them.

Twenty million dollars will not stretch, but they will shrink. There is a maximum limit to what a given sum can accomplish, but there is no minimum. Money can be so expended as not to get the best possible results. It can be expended in a fashion economical at the moment, but extravagant in the long run. It is extravagant to adopt any procurement policy calculated to weaken the aircraft industry. It is extravagant to accomplish procurement in any way which will discourage any individual manufacturer from keeping up his engineering and experimental departments, or from regularly and constantly undertaking experimental designs.

The American aircraft industry had many complaints against the procurement policies of the Army or Navy in the seven years immediately following the War. Many of the objections were fundamentally sound, but sound, also, was the reply of the procurement authorities that their practices were defined and constructed by law and that they were not at liberty to ignore legal stipulations. General legislation on the purchase of supplies was being made to cover the special case of the airplane. To ease the situation the Aircraft Procurement Law of 1926, the famous Section 10 of the Army Air Corps bill, was enacted. It wasn't a perfect law. Time has revealed flaws in it, but it was well meant; it was a great improvement over what previously existed, and for the moment it is all that we have.

The Aircraft Procurement Law recognized that flying equipment cannot simply be bought on specification like shoes or hammocks or rolling kitchens. It was intended to recognize that there must be some consideration of the rights of the orginal developer of the design if experimental work is to go forward as it should,—although for some curious reason the recognition of property in design was made absolute only in respect of designs produced prior to 1926. It recognized that, in the interests of safety, the responsible officials of the governmental services must have the authority to reject the offer of any bidder not considered adequately experienced or equipped and competent to do a proper job. It recognized that to foster price-cutting or to lay stress upon price competition between manufacturers may ultimately prove to have been a very expensive way of saving money for the government.

The Procurement Law did more. It undertook to emancipate the Army Air Corps and the Naval Bureau of Aeronautics from the despotic sway of the Controller General. It expressed the confidence of Congress in the integrity of the officers of the services, and gave them virtual *carte blanche*, subject only to the mildest restrictions. It gave them the authority, after asking for competitive bids on material, to ignore the lowest bidder and award the contract elsewhere if in their judgment the best interests of the government would be served thereby.

The procurement authorities felt a natural and proper reticence about making use of the authority so generously conferred. They kept the strongest of their new powers in reserve for use only in necessity,—but unfortunately at times it appears to be too far in reserve, when it should have been brought up into the front line trenches and put to work. The law was enacted very largely for the purpose of providing that property in design might be respected, and that the originator of a type might be given proper preference when further construction based on his design was projected. Obviously it was impossible to define the exact amount of preference which would be proper, for it is subject to infinite variation with circumstances, but it seems to us that it should be substantial—substantially larger than the services have at times been prepared to concede. At the very least the orginator's bid should be favored by a differential representing his out-of-pocket expenses on the design up to that point.

We do not believe that it is proper that the putting of a new design into production before it has had a

thorough trial on an experimental scale should ever be risked, except under the most extraordinary circumstances. We do not believe that a design prepared and developed by one manufacturer should ever be taken from him and given to another, except with his full approval or in the event of actual or immediately threatened war requiring that all other considerations be sacrificed to speed. It is very disturbing, and to our mind it is very dangerous to the stability of the aircraft industry and to the success of the efforts of the Army and Navy to obtain the best possible equipment, that designs should be shuffled about within the industry or that an experimental design, either of a complete airplane or of any important component possessing novelty of conception, should be handed over to another manufacturer than the originator for immediate production. Of course we do not imply that those things are comon practice. Fortunately they are quite rare, but they can still occur on occasion, and very recurrence is fearfully upsetting to the stability of the industry. The ideal system would be one, akin to that under which engines are now purchased, which left no opening at all for competitive bidding on the same design, but called for each manufacturer to bid on his own product, with the condition that bidding be limited to those who had already submitted for trial a sample of the proposed model, or of one essentially like it except in detail. The services, and especially the Army, already approximate to that in their procurement of several of the classes of aircraft. It ought to be as nearly as possible universal practise.

This seemed a matter of some importance five years ago, but it is far more serious now. The cost of building experimental airplanes has steadily increased. The price paid for them by the Army and Navy has not kept pace. Practically every such machine is now constructed and tendered at a heavy loss to the builder. That is fair enough if he is assured of full rights in any further construction of the type, for then he is merely asked to make a stake upon his own success in meeting military requirements. If his design rights are likely to be spirited away and the results of his labors turned over to another company to enlarge upon and profit from, it is most unreasonable that an initial loss should be imposed upon the constructor of the initial machine.

The question of design right is closely allied with that of price determination. Selling aircraft to the Army and Navy is unlike selling in any commercial market in the world. At best there are only two buyers in the market. Usually there is but one. Whether there be one or two, their own interest is deeply involved in the maintenance at full strength of the industry from which they buy.

The service procurement officers have it in their power, in the present state of the industry, to force manufacturers to take almost every order at cost or below. For a time, they can get an unprecedentedly large number of airplanes for the money appropriated. In any case they can force the manufacturer to swallow his loss on the original experimental example, making no attempt to amortize it on the production order that follows. But the wisdom of such a course is quite another matter.

Just at present there happens to be no dearth of experimental construction, but if the closest possible buying is to be the objective of the services, and unless the full loss on developing a new design is to be credited to the contractor and made up in the course of the first production order, new design will dry up at the source. To make sure that the vigorous development of the last two or three years will continue, there must be a deliberate decision on a policy of increased liberality in fixing prices on contracts.

If buying be too close, and if too much pressure be applied to force prices down, it is not the procurement officers of the services that are at fault. It is not to them that we should finally turn for relief. Their responsibility is to get as much as possible for the money expended. But there comes a point at which general administration policy is involved, and at which administration policy should be more clearly defined for the benefit of those who execute its details.

The President and his trusted associates have been firm against wage reductions. The preservation of wage scales have been the first plank in the official platform throughout the depression. It would be well for the administration's right hand to inquire into what its left hand is doing. There are companies building airplanes for the government having no other market, their practices absolutely dictated by the terms upon which the government purchases, that have been driven into making general wage cuts in order that they may take orders at the prices that the government will pay and still survive. Does the government at Washington intend to force airplane manufacturers to choose between scrapping their plants and operating them, even after wage and salary reductions and all other economies have been made, at an average rate of return on capital less than they could get by depositing it in savings banks? It is a question of profound significance in defining the attitude of the administration towards industry. It is one upon which the Secretaries of War and of the Navy ought to declare themselves.

H. C. PARMELEE, one time editor of *Chemical and Metallurgical Engineering,* and editorial director of the McGraw-Hill Publishing Company since 1928, on Nov. 2, 1931, was appointed vice-president of the company. Long associated with the chemical and mining industries in a professional capacity, Dr. Parmelee was a trustee and president of the Colorado School of Mines before he entered the editorial field.

News of the Month

The Akron joins the Navy

ON OCT. 27, with brief ceremonies in its dock at the Lakehurst Naval Air Station, the U.S.S. Akron was formally received from the Goodyear-Zeppelin Corporation, commissioned as a "ship of the line" of the U. S. Navy, and turned over to Lieut. Comdr. Charles E. Rosendahl. The new airship completed its final tests on Oct. 18 after a ninth test flight, which covered 2,000 miles over mid-western states in about 48 hours, completing the prerequisites for acceptance by the Navy. The only criticism was a two-knot deficiency in top speed, that may be corrected by adjustment of the propellers. As a final fling before settling down to Naval routine, 207 passengers were carried on a ten-hour flight, exceeding by 38 persons the record established by the Do.X at Lake Constance two years ago.

With the acceptance by the Navy of the Akron, the contract for a second airship, automatically becomes operative, the privilege of cancellation contained in the original contract for two airships having been limited to the period prior to the acceptance of the first. The ZRS-5 will have a capacity of 6,500,000 cu.ft., the same as the Akron, from which it will differ only in such degree as improvements are suggested in the operation of the first airship, but will cost only $2,450,000, almost half of which has already been appropriated by Congress.

Sunnyvale base assured

Permanent accommodation for the Akron at Sunnyvale, Cal., just north of San Francisco, is now assured. The final contract for a hangar there was awarded on Oct. 20. The contract for foundations, grading, and the main tracks to the station goes to the Raymond Concrete Pile Company of New York City, whose bid was $181,181, bringing the total cost of the hangar to $1,696,162. Details of the contracts for the hangar proper were given in the November issue of AVIATION.

The first Marine Corps airplane squadrons ever organized for duty afloat, have been assigned to the Saratoga and Lexington. VS-Squadron Fourteen-M and VS-Squadron Fifteen-M, composed of six scouting planes each, have been commissioned and will become units of the regular operating aeronautical organization of the Navy, in order to give the Marine Corps pilots experience in carrier operations. Eight commissioned and four non-commissioned officers have been assigned to each carrier. The need for such duplication of naval and Marine Corps experience and activity has not been made clear.

Naval affairs

The Saratoga and the Lexington are the only carriers which the Navy now maintains in the waters adjacent to the United States. The Langley is to go to the Far East to relieve the Jason, an aircraft tender, upon which the schedules of the Asiatic fleet have been based. It will be the first American carrier to operate in Asiatic waters where the British have maintained the Hermes for some time.

Final estimates for the Navy budgets for the coming fiscal year are $17,000,000 below the 1932 appropriations, while Army budgets have been cut some $44,000,000. Though in neither case is it clear how far these will apply to aviation activities, it seems probable that aviation will be little hit by the reductions.

Of interest to pruners of national defense budgets should be the ferrying job just completed by the Navy. About a quarter of a million dollars in crating and shipping costs was saved by ferrying twenty new patrol planes from the Glenn L. Martin plant in Baltimore to the Fleet Air Base at Coco Solo, Panama. The last group of the planes, which are to be attached to the U.S.S. Wright, aircraft tender of the scouting force, completed the 2,300-mile trip on Oct. 10.

The Navy Department has just awarded a contract for 858,000 gallons of Stanavo Aviation Gasoline, which are to be delivered by three of the companies participating in the Stanavo Specification Board to various naval stations and to the Lexington and Saratoga and other vessels maintaining flying equipment.

Contracts recently awarded by the Navy Department will secure for it two new types of equipment. The Berliner-Joyce Aircraft Corporation has contracted to build eighteen two-place observation planes of a new type, for $463,700, or a unit price of about $20,600 without spares. Designed to fill a need for a lighter and smaller plane to supplement the Vought Corsairs now in use, the XOJ-1 can be operated either from the catapults of battleships and cruisers as a seaplane or as a landplane on the carriers.

A new bomber, a further development of the Martin studies in heavy diving bombers which began about three years ago with the XT5M-1, and capable of delivering a 1,000-lb. bomb from a vertical drive, is being built by the Glenn L. Martin Company. The Navy contract calls for sixteen planes at a unit price of about $26,700, spare parts also being included in the total cost to the department of $534,662.

Still other Navy orders have been placed with the Chance Vought Corporation. An initial contract for fifteen observation planes of the type O3U-2, the latest Corsair, already in use in the service, at a unit price of $15,000, was followed by a second order for 28 planes of the convertible model O3U-3, Wasp-powered and equipped with pontoons also to be built by the Vought company. These will cost about $17,400 per plane, while a contract for 65 planes of the O3U-4 designation at $14,000 each brings the total cost with spares to $2,024,961.

Army also buys

Contracts approved for the Army Air Corps also are largely for new models. Among the planes expected to rival the best high-speed performance of British fighters is a two-seater, low-wing attack monoplane designed and manufactured by Curtiss and to be equipped with one liquid-cooled V-1570-E Curtiss engine rated at 600 hp. Thirteen have been contracted for at a cost of $26,300 each, with parts and instruments bringing the total cost to $427,615.

Contracts with the Detroit Aircraft Corporation represent the first orders for combat planes based principally on commercial experience, the use of planes designed outside the "military industry" having previously been limited to transport and utility types. The con-

Calendar

Nov. 22-Dec. 4	International Glider Meet, Honolulu, Hawaii
Dec. 3-5	National Association of State Aviation Officials Meeting, East St. Louis, Ill.
Jan. 7-9	Fourth Annual Miami All American Air Races, Miami, Fla.
April 2-10	National Aircraft Show, Detroit, Mich.

tract with the Detroit company calls for five Lockheed two-seater pursuits priced at $27,600 each, spare parts additional, designated Y1P-24 and to be powered with Curtiss V-1570-E engines. Another contract of later date specifies five Lockheed attack planes at a cost of $26,600 per plane without spares. Designated as YA-9, these are to be low-wing models of metal monocoque construction, Curtiss-powered.

The Douglas Aircraft Company is the recipient of contracts for 35 planes at a total cost of $718,876 with spares. Five are to be two-seater, high-wing monoplanes of the observation type, each powered with a 600-hp. Curtiss engine. Each will cost the Army $18,350. The first machine of the type has been under trial for some months. Another contract is for twelve twin-engined planes, with Curtiss engines, prestone-cooled, intended to test the comparative efficiency of prestone-cooled and air-cooled engines. Five are observation planes, seven a light bombardment type. The third contract is for a standard type, which has the Air Corps designation O-38B and closely follows the design of early Douglas biplanes. Eighteen are ordered at a unit price of about $9,000 for the use of the National Guard.

In publishing a summary of airplane contracts and deliveries for the fiscal year 1931 the Air Corps has departed from its usual procedure. A total of 608 planes ordered and 479 delivered is reported for the twelve months ending June 30 last. The list of contractors is headed by Douglas, from whom 234 planes were ordered and as many delivered, while Boeing is second with contracts for 165 planes. The Thomas-Morse Corporation, with Army orders for 101 planes, is next in line, while the next nearest scores are of 32 and 30 planes ordered from the Fokker company and Curtiss, respectively.

The recently issued annual report of the Chief of Air Corps, also covering the fiscal year, contains the usual details regarding changes in personnel strength, training, and operations, as well as airplane and lighter-than-air developments and research. Especially favorable is the accident report for the Air Corps, which shows an increase of 114 per cent in flying hours per fatal accident over the 1930 figures, along with a 22 per cent increase in total aircraft hours.

Detroit keeps the aircraft show

Once again, April 2 to 10, 1932, Detroit will be the scene of a National Aircraft Show. Ray Cooper, who directed the National Show of 1931 will have charge of the coming exhibition, which will be staged with the full cooperation of the Aircraft Bureau of the Detroit Board of Commerce under auspices of the Aeronautical Chamber of Commerce.

The United States Amateur Air Pilots Association is improving its organization by the appointment of a governor in each state to supervise the activities staged therein under the Association's auspices. The Association will supervise the amateur cruise to Miami and all amateur events at the annual Miami races, scheduled for January, 1932, for which the usual preparations are being made.

The second active unit of the Aviation Country Clubs in the United States has been dedicated, at the Curtiss-Essex Airport at Caldwell, N. J. The club house has been opened and a broad program of activities, in cooperation with the Curtiss-Wright Flying Service at the field, planned for the coming year.

Recent outstanding flights

Miss Clara Livingston, a recent addition to the list of amateur pilots, has become the first woman to fly her own plane over the Caribbean, where Pan American Airways have heretofore had almost a monopoly of civil flying. Purchasing her plane in New York, Miss Livington took off from Roosevelt Field and flew to her winter home near San Juan, Porto Rico, in something less than a week, by short stages.

Another plane over the Caribbean in late October was the "Karachi" of Bert Hinkler, famed Australian flier and first to fly solo from London to Australia or to accomplish the trip in fifteen days. He flew from North Beach, Long Island, to Kingston, Jamaica, non-stop in eighteen hours—1,800 miles, almost all over the open sea. His Puss Moth was the first plane ever to land on the island itself, all previous visitors having arrived in seaplanes.

A few days later a Puss Moth scored a triumph on another continent. Miss Peggy Salaman and her co-pilot, Mr. Gordon Store, flew from England to Cape Town in five days and nine hours, 25 hours and 23 minutes better than the late Commander Glen Kidston's Lockheed-made record of 154 hours for the 7,000 miles. The trip was made in about 64 hours flying time.

In an even smaller plane than the Moth, C. A. Butler, one of the smallest of British pilots, has set a new record for the England to Australia flight. In his Comper-Swift monoplane, powered with a 75-hp. Popjoy engine, Mr. Butler bettered the previous record made by C. W. A. Scott by about an hour. His plane weighs 546 lb., is 100 lb. lighter and carries 25 less horsepower than any other that has attempted the flight.

Major James H. Doolittle, in the same little green Wasp-powered Laird racer in which he made a new transcontinental record, recently made a dawn-to-dusk flight between the three chief North American capitals, something new in inter-city flying. Taking off from Rockcliffe Airdrome in Ottawa shortly before dawn, he stopped at Washington, Birmingham, Ala., and Corpus Christi, Tex., and landed at Mexico City twelve hours and 36 minutes later. The actual flying time was eleven hours and 45 minutes, an average of 235 m.p.h. for the trip. On this, as on his transcontinental flight, high-compression pistons and a supercharger raised the normal power of the plane's Wasp Junior engine to 540 hp.

In a flight from Hill No. 6 near Elmira, Dr. Frank Gross and Howard Funk established a soaring record which, though unofficial, is unusual. Seated side by side in a two-place utility glider constructed by Dr. Gross they soared for two hours and thirteen minutes and reached an altitude of 2,400 ft., both unprecedented achievements for the two-place glider with which little has been accomplished previously even in Germany.

N.A.C.A. opens doors

The National Advisory Committee for Aeronautics at its annual meeting on Oct. 22 decided to permit the use of the facilities of its Langley Field laboratory by individuals in the aircraft industry, providing they are willing to bear the expense of the research. Test projects not of general interest to the industry, yet capable of being carried out only at the Langley laboratory may now be conducted for the benefiit of individual manufacturers, who will receive the results, though the Committee reserves the privileges of releasing them for general distribution at its discretion. Col. Charles A. Lindbergh has been appointed to the Committee to fill the vacancy left by the death of Dr. Samuel W. Stratton, one of the three organizers of the N.A.C.A. and a member of the group since its formation.

Though a take-off was made from the roof of a Seattle department store in 1912 by Silas Christofferson and a landing made (with crash) at a somewhat later date on the roof of the Galeries Lafayette in Paris, the experiment made recently in Grand Rapids, Mich., with a Heath Parasol was unique in that both landing and take-off were made and without damage to either plane or roof. The plane has a wing spread of 25 ft., the roof dimensions were 80 x 390 ft.

Aquatic 'giros

While the American Navy has been experimenting with the use of autogiros equipped with floats, the British and French navies have been concentrating recently on the development of autogiro flying boats. The British model, constructed by Short Brothers, and the two flying boats being completed for the French navy in the Avions Weymann factory are expected to extend the functions of the more conventional flying boat by their ability to operate in rough water and to improve and simplify reconnaissance systems which are now based on the use of airships. The Wey-

Air Corps

LARGEST AIRPORT

Randolph Field, the Air Corps' new training center at San Antonio, is now in commission. Lower: The living quarters and hangars.

man firm is directed by the American of that name, many years resident in France, who won the Gordon Bennett airplane race for the United States in 1911.

Private flying in France has been promoted, for the past two years, by the granting of subsidies by the government under the decree of April 17, 1930. *Foreign Aeronautical News*, published by the Aeronautics Trade Division of the Department of Commerce, reports that 216 purchasers have received subsidies, varying with the type of plane, but averaging $1,200 each, about half the first cost of the plane. Only planes manufactured in France are eligible.

Government contracts under production at the plants of the Boeing Airplane Company are not only keeping them running at full speed, but are also responsible for the addition of 6,000 ft. of floor space to facilitate the assembly of the long fuselages of the Boeing twin-engined bombers. Two of these bombers, one powered with geared Hornet engines, the other with liquid-cooled engines, are ready for delivery to the Army Air Corps on a contract for seven. The first sale by the Boeing plant to Siam, negotiated through United Aircraft Exports, is scheduled for shipment from Seattle in November. The Siamese government is the purchaser of the two Model 100-E single-seater Wasp-powered Boeings.

Government orders are also keeping the factory of the Douglas Aircraft Company, with 1,200 employees on the pay roll, working at capacity. Douglas sales for the first eight months of this year are reported as almost equal to the total for the entire year just preceding.

Lycoming-powered Stinson Junior planes have been ordered by the Aeronautical Commissions of five states for the use of their inspectors, and two of the same model have been purchased by the Department of Commerce.

Mexico's only airplane factory is in a less happy condition. Gen. Juan F. Azcarate, its owner, has petitioned the labor courts for permission to dismiss his employees so that the factory may be shut down. He reports no private field for sales and government economies now have cut airplane contracts from the budget.

Moving days

The Nicholas-Beazley airplane company has entered into an agreement with Ole Fahlin, designer of the Fahlin propellers. All equipment and machinery for their manufacture, previously carried on at the Kari-Keen plant at Sioux City, Iowa, are being moved to the Nicholas-Beazley factory at Marshall, Mo., where they will be produced in the future.

The Hamilton Standard Propeller Corporation has completed the move of its office and production force from Pittsburgh to the Pratt & Whitney Aircraft factory at Hartford.

The new firm of Stearman-Varney, Inc., has opened offices at the San Francisco Bay Airdrome, with Lloyd Stearman, formerly of the Stearman Aircraft Company at Wichita, as chief engineer, and Hall Hibbard, also of the old Stearman group, as supervising engineer. The director of the Viking Flying Boat Company, Robert Gross, will play a leading part in the new organization. Walter T. Varney, founder of the Varney Air Lines, is backing its development of high speed transport planes, which it plans to manufacture in addition to sport types.

On financial matters

To facilitate plans for the reorganization of the Detroit Aircraft Corporation units into a lighter-than-air and a heavier-than-air division as announced in the November issue, Peter R. Beasley of Detroit, president of the company, and the Title Insurance and Trust Company of Los Angeles were appointed receivers in equity. The receivership was thought necessary to maintain assets intact until reorganization plans could be ratified by the stockholders, whose annual meeting in October was postponed until sufficient proxies could be obtained for a quorum. The Lockheed plant at Burbank, Cal., is working two shifts six days a week on

military and commercial orders, chiefly for the Orion model. (See page 669 on their pursuit and attack orders.)

A temporary receiver has been appointed for the Pittsburgh Airways, Inc., in the Common Pleas Court of Pittsburgh on the petition of a stockholder. They are operators of a New York-Pittsburgh line.

Financial reports for the first nine months of the current year have been made by several corporations. Though the Aviation Corporation of Delaware reports for that period a net loss of $917,907, including losses on the sale of securities, its report for the three months ending Sept. 30 shows a profit for the first time in the company's history. The net profit for the third quarter of 1931, not including sales of securities, was $6,543, to be compared with a net loss of $775,112 in the same period of 1930. The net loss for the current nine months, which may be reduced to $479,693 by the exclusion of losses on the sale of securities, should be compared with net losses of $4,051,534 and $4,022,154, respectively, for the first nine months of the preceding year.

In the face of a 44.5 per cent reduction in the total earnings for the third quarter of 224 miscellaneous leading industrials listed by Standard Statistics for *Business Week*, the three aircraft companies included—Aviation Corporation, United Aircraft and Transport, and National Air Transport—showed an increase of 35.4 per cent over the same period of 1930. For the first nine months of the year the aircraft group, to which the Waco company had been added, was the only one to change a deficit in 1930 to black ink in 1931, making a larger absolute gain than appears in any other industry except coal.

National Air Transport, Inc., reports for the first nine months of this year a net profit of $569,603, about 87 cents a share, to be compared with $576,391, or 88 cents on each share of stock outstanding for the same period of 1930. Net profits for the three months ending Sept. 30 were $248,350, after charges and federal taxes, equal to 38 cents a share on capital stock which in the third quarter of 1930 earned 35 cents.

Net income of United Aircraft and Transport Corporation for the three months ending Sept. 30, after taxes and depreciation, was $742,567, equivalent after preferred dividends to 27 cents a share on 2,083,791 shares of common stock outstanding. Earnings for the same period of 1930 were $1,149,614, about 47 cents a share. For the first nine months of the current year the net income of the company was about $2,235,000, which after the deduction of $540,000 for transferred dividends is equal to 81 cents a share. The company's holdings in National Air Transport account for about 25 per cent of the net.

Operations of the Kinner Airplane and Motor Corporation, Ltd., during the first six months of 1931 resulted in a loss of about $89,000.

FOR THE STRATOSPHERE

The Junkers Ju 49 high altitude plane, powered with the Junkers L 88 engine, which has special supercharging equipment. The cabin is strengthened and sealed to withstand high altitude pressures. Preliminary test have been made and the design is in process of modification.

Legal developments

The material immediately following, together with reference to legal and legislative matters elsewhere in the news pages, is based largely upon the Aviation Law Service prepared by the Commerce Clearing House, Inc. AVIATION is licensed to make use of this service, and is able to give its readers the benefits of the work of an organization specially trained and equipped to insure the complete collection of pertinent material on current legal developments.

Hearings in the stick control patent suit of Robert Esnault-Pelterie, the revival of whose suit against the U. S. Government was reported in the November issue, against Chance Vought Division, U. A. & T., have been concluded. The case before Justice Campbell of the U. S. District Court in Brooklyn, N. Y., is closed except for presentation by the plaintiff of original decrees of the French courts in Mr. Pelterie's various suits. At the hearing only translations of the French decisions were available, and the defense refused to admit those. Calendar considerations will probably delay Justice Campbell's decision until late December or early January. The date set for exchange of briefs was Nov. 30. A victory for M. Esnault-Pelterie in the Vought case would presumably be followed by the filing of suits against many other manufacturers, and the amount of money at stake is enormous.

That insurance bugbear

The perennial problem of insurance company liability in the case of the death of an insured person in an airplane crash is under discussion in St. Louis courts. The Circuit Court had decided that is the case of Delbert H. Flanders, suing to recover the insurance of his son who was killed in 1928 in a crash of a plane in which he was a passenger, the insurance company was freed from liability because the insured met death while "engaged in aeronautics." A new trial is being granted by the Court of Appeals, however, on the grounds that riding as a passenger does not constitute being "engaged in aeronautics."

At a recent meeting of the American Life Convention a complete detailed method for underwriting aviation pilots for life insurance was presented by the aviation committee. The plan suggested requires an extra annual basic premium of from $33 to $8 per thousand dollars of insurance, depending on the total number of flying hours reported by the prospect. Penalties in the form of additions to the premium are imposed for solo time less than 4,000 solo flying hours, for violation of traffic rules, and for hazardous types of flying. Transport pilots with more than 4,000 hours flying are considered the ideal. For pilots whose flying is under the supervision of qualified flight officers, and is between 50 and 499 hours annually, no additional premium is suggested, but if the annual flying rate is greater, a premium of from $8 up is proposed.

In a test case in England, the County Court at Croydon would not allow the dependents of a pilot compensation under the Workman's Compensation Act, since the flying of airplanes does not come under its definition of manual labor. Such compensation is generally allowed in this country, and air transport lines are covered by compensation insurance.

The International Air Traffic Association, which includes practically all the airlines of Europe, is at present considering questions of insurance and liability. It is planned to limit the liability of an air transport company in case of death or personal injury to a passenger to 125,000 French francs ($5,000) provided it can be proved that the operator was at fault. There would be no liability except in the event of proven negligences. Registered baggage liability will be limited to about $4.45 per lb., unless special declaration of value is made. All this generally follows the provisions of the Warsaw Convention on private air law, drawn up in 1928.

Reciprocal airworthiness certificates

A reciprocal air navigation arrangement has been entered into by the United States and Italy, effective Oct. 31. Though similar in general to the agreement now in force between the United States and Canada, that with Italy places more emphasis on reciprocal trade arrangements and contains a most-favored-nation clause with respect to the operation of aircraft. Certificates of airworthiness for aircraft, and acceptance test certificates for aircraft engines and for spare parts of aircraft and engines built in either country and exported to the other, will be accepted by the aeronautical authority of that country, if issued in accordance with its own requirements for airworthiness. The red tape involved in exporting American aircraft is thus enormously reduced. Though Italy is the first European country with which an air navigation agreement has been concluded, similar arrangements with others are pending.

The judicial Committee of the Privy Council at London has allowed the appeal of the Dominion Government of Canada against a decision of the Supreme Court of the Dominion in regard to the jurisdiction of the Dominion government over aviation matters. The challenge by Quebec in 1927 of the right of the federal government to enact legislation which restricted the authority of the provinces over aerial operations within their own boundaries had been upheld by the Canadian Supreme Court, which would have limited Dominion authority to international aviation activities. The Dominion's contention to supreme jurisdiction was supported by the tribunal in London and also, incidentally, the validity of Dominion aeronautical legislation which has been challenged by the provinces. This is directly in contrast with the American situation, where constitutional restrictions limit the jurisdiction of the Department of Commerce to interstate activities.

Licensing changes

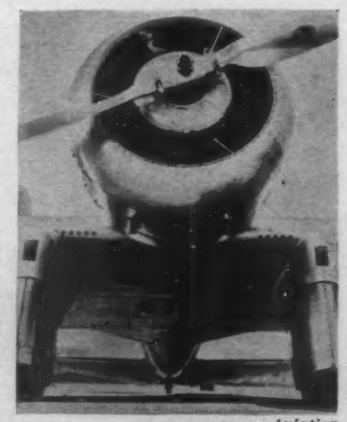
Under new regulations adopted by the state highway commission of Oklahoma, vested by the last legislature with state aircraft regulation, the state joins Pennsylvania in requiring state licenses for all airplanes and pilots, but with federal licenses a prerequisite.

Rules and regulations to govern air navigation in the Panama Canal Zone, supplementary to and enlarging upon regulations contained in executive orders of 1928 and 1929, have been established and promulgated by the Secretary of State. Though modeled on the Air Commerce Act, the Canal Zone code contains in addition regulations prohibiting flying over certain areas, limiting the arrival and departure of aircraft to certain hours of the day, and specifying routes to be followed across the isthmus.

Violations of the Air Commerce Regulations during the third quarter of 1931 totalled 438, an increase of 128 over the report for the second quarter of the year. Fines totalling $370 were assessed and collected from 89 persons. Sixty-one others were reprimanded, licenses were suspended, revoked or denied in 151 cases, 137 were dismissed.

Several changes have been made by the Aeronautics Branch in rules covering the licensing and rating of pilots. Provision is now made for licensing pilots of the "unconventional" types of aircraft being flown in increasing numbers. Practically speaking, this means autogiros. A revised rating sheet is used in connection with the license, upon which must be indicated the transport or limited commercial pilot's authority to carry passengers for hire in unconventional types of aircraft, obtained by passing a flight test in flying the specified type. Licensed pilots now holding licenses of lower grade may fly unconventional types without additional rating, while pilots receiving their training in these planes will be issued special licenses.

Department of Commerce eyesight requirements have been liberalized to permit and also require aspirants to student and private pilot licenses, whose vision is defective, to wear correcting lenses while operating planes. Under the new regulations, even if an applicant's vision without glasses does not meet the requirement of 20/50 in either eye, he may be issued a student permit qualifying him to be a private pilot if his vision is improved to 20/30 or better by correcting lenses. The 20/30 fraction means at a distance of 20 ft. from the vision-test letters, a person can read what with normal eyesight would be read at 30 ft. The new requirements are only slightly more severe than those imposed in many states on all automobile drivers.



Aviation

A NEW BETA

Interesting view showing some design details of new model Beta recently test flown across country by E. T. Allen

Ludington record broken

Ludington Airlines, Inc. (formerly called New York, Philadelphia and Washington Airways Corporation) experienced on Nov. 5 its first real crash in more than 1,600,000 miles of flying, when a Lockheed Orion of its high speed, non-stop service between New York and Washington plunged to the ground from about 150 to 200 ft. as it was coming in to land at Camden Airport, Philadelphia. The wreck caught fire immediately; Floyd C. Cox, the pilot, Vernon Lucas, company pilot riding as a passenger, and three passengers were lost.

Though Camden Airport is not a regular stop on this service the pilot had planned to land there on that particular trip to accommodate a passenger. No official announcement of the cause of the accident has been made, but it had the general characteristics of a whip-stall after loss of flying speed. There has been no official evidence of plane or engine failure. The high speed service was suspended, apparently only temporarily.

Traffic dips

Traffic on airlines was 8 to 4 per cent less during the first six months of this year than during the same period in 1930. Greater declines, however, were shown by other transportation services. Class I railroads were off 14.7 per cent, eastbound trans-Atlantic steamship travel 18.2 per cent, and westbound 51.8 per cent.

Pan American carried 31,202 passengers and 1,338,831 lb. of express and mail during the first nine months of the year. Century Air Lines in the Mid-West carried 6,110 revenue passengers in October, maintaining its average of 6,000 per month since the start of operations in March.

During August and September Boston-Maine Airways, first airline organized strictly by railroads, carried about 2,000 passengers, and then suspended for the winter. Service is expected to be resumed next spring. Concern over loss of patronage to airlines by railroads was expressed at the annual meeting of the American Association of Passenger Traffic Officers at Chicago in October. It was the consensus that airline patronage had grown, on the whole, despite the depression and that with economic improvement more passengers will be taken from the railroads. Also, that two checks to losses to airlines are open—participation in air transportation and in regulation. This latter is regarded as the most effective for the present.

Among the latest to announce fare changes is Eastern Air Transport. The one-way fare between New York and Miami has been reduced from $86.61 to

$74.45 and the round trip from $173.22 to $131.20. The round trip rate is about 5 cents per mile, the one-way fare about 6. The new round-trip and one-way fares between New York and Washington bring Eastern's charge down to the level of its competitor over that route, Ludington.

Eastern has just received Department of Commerce permission to install the recently-demonstrated Sperry gyro-pilot in its six Condors. Before the additional installations are made, however, all pilots will operate the original demonstration plane to become accustomed to the device.

Bus-plane idea

The newest innovation in air transport circles is the coordination of bus and air service by Transcontinental & Western Air and Greyhound bus lines. Buses will not meet the planes at all airports; it will be necessary for passengers to take the usual airport-city vehicles to make connections through downtown bus terminals. Chief advantages of the new connection lie in the possibility of making through reservations to and from points not touched by an airline and in the handling of T. & W. A. tickets by Greyhound agents. The bus-plane alliance follows the lead set by similar arrangements between airlines and railroads, and supplements further the widespread ticket representation provided by Postal Telegraph. A plane-bus package service is to be introduced, and in the meantime T. & W. A. has arranged for interchange of express with Pennsylvania Airlines and United States Airways.

The most important recent extension of airline operation is the inauguration by Pan American of passenger and mail service between Santos, Brazil, and Buenos Aires, a gap of slightly more than 1,000 miles, which P.A.A. has not operated since it took over Nyrba more than a year ago. This completes the actual encircling of South America by the Pan American system. Flying boats and amphibions are used throughout the entire east coast route. the Fokkers formerly used in the West Indies runs being shifted to the Mexican Aviation company division. Planes depart for the south from Miami every Monday morning, arriving at Buenos Aires a week from the following Tuesday.

Varney offers speed

Varney Air Service inaugurated its fast passenger service between San Francisco and Los Angeles on Oct. 15. The 372-mile route is flown in an hour and 58 minutes, the San Francisco-Sacramento route of 80 miles in 22 minutes. Lockheed Orions are used. On Nov. 9, Transamerican Airlines placed tri-engined Fokkers in service between Detroit and Cleveland by way of Toledo for passengers and mail to replace the seasonal amphibion service operated across the lake. The company further improved its passenger and mail service by shifting its late afternoon plane between Pontiac, Detroit and Chicago to the evening, the machine leaving Pontiac at 8:30 p.m. Braniff and Bowen airlines are cooperating to provide 6½-hour service over the 900 miles between St. Louis and San Antonio. Southbound passengers transfer from Braniff to Bowen planes at Tulsa.

The grist of foreign airline news includes mention that in Russia's application of the Five-Year Plan to aeronautics the country already has opened 18,000 miles of airways of the 80,000 projected. A total of 55,000 miles are expected to be in operation within a year. Last year Russian aircraft carried about 11,700 passengers and 250 tons of freight.

Air mail troubles

With a special subcommittee of the House of Representatives making final preparations for investigating the Post Office Department's methods of awarding air mail contracts soon after the reconvening of Congress in December, a new bone of contention—the proposed abandonment of the lighted Norfolk-Washington airway—has been thrown into the controversy between the operators holding mail contracts and the independents.

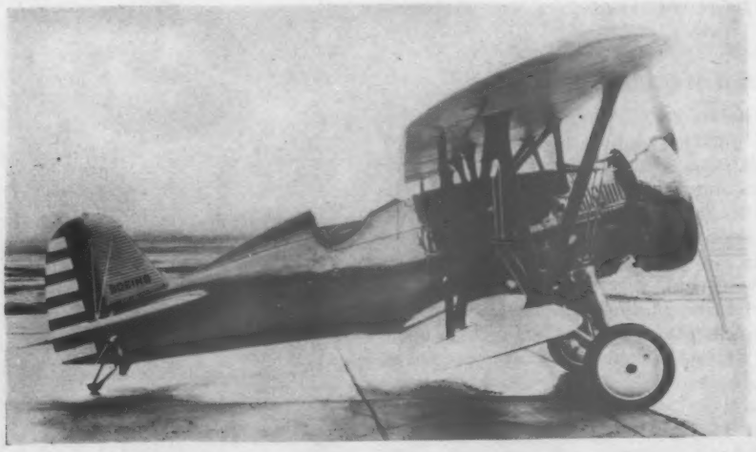
Again the Ludington line is challenging the relations between the Post Office Department and Eastern Air Transport, even as it added fuel to the controversy in its earlier stages last summer by complaining about awards to Eastern of the New York-Atlantic City and Philadelphia-Atlantic City contracts, and about the government's dismissal of Ludington's offer to carry the New York-Washington mail at a rate far below that now granted Eastern.

The Norfolk-Washington airway was laid out and lighted by the Department of Commerce last year at the instance of the Interdepartmental Committee on Airways. It was expected to be an extension of the present Washington-Pittsburgh route. In anticipation of the contract bidding, Ludington inaugurated passenger service between the two cities on Oct. 15. However, with the same contract in view, Eastern began service between Norfolk and Washington by way of Richmond on Oct. 23, the day after the Post Office Department announced that it would not use the lighted route after all, preferring the shorter one between Norfolk and Richmond. It is intimated the mail contract will go to Eastern under the extension provisions.

All interests are preparing vigorous representations. The main issue is whether or not air mail contracts are being unfairly concentrated largely in the hands of four principal transportation companies under the extension system. An important sub-issue will be alleged practice of wording contracts so that in one way or another only one company, usually already a contract holder, will be successful.

Another complaint to the Post Office Department made by Representative F. H. LaGuardia, of New York declares that at least four operations managers and between twelve and fourteen pilots not citizens of this country are being employed by Pan American Airways, holder of a number of foreign air mail contracts, and demands that these individuals be discharged in favor of American citizens. Pan American, in Mexico and in certain other areas of its vast operations, is obliged under domestic law to employ native help. In no case, however, do these employees include major executive officials.

Representative Clyde Kelly of Pennsylvania, ranking member of the House Committee on the Post Office and Post Roads, sponsor of the original contract



A NEW LANCE

The first of 135 new type Boeing Pursuit planes for the Air Corps. It has a metal monocoque fuselage

COL. THOMAS C. TURNER, chief of Marine Corps aviation, died on Oct. 28 of injuries received from an airplane propeller. Landing in a muddy field at Gonaives, en route from Washington to Haiti, he attempted to dislodge his plane, slipped, and was hit by the flying blade. Col. Turner had received the Distinguished Flying Cross in 1921, for leading a flight from Washington to Santo Domingo, the longest unguarded land plane flight over water up to that time, and has seen noteworthy service as aviation leader with the Marines in Haiti and in China.

EDWARD C. RITCHIE, test pilot for Glenn L. Martin Company and former naval aviator, was killed in a test flight over the Naval Air Station at Anacostia, D. C. Making a test dive from about 8,000 ft., the bombing plane which he was piloting seemed to disintegrate, Ritchie's parachute became entangled in the plane, and he fell with it.

LIEUT. COMDR. OSCAR W. ERICKSON, U. S. Navy, died Nov. 5 as the result of a crash over the side as he attempted a landing on the aircraft carrier Saratoga on which he was stationed. Commander Erickson was one of the naval men sent to the Massachusetts Institute of Technology for special training in aeronautical engineering in 1924. His was the first fatal accident in a landing on an airplane carrier.

air mail bill and the avowed exponent of another air mail investigation if the one now authorized and pending does not prove satisfactory to him, expects favorable action this winter on a bill to provide air mail contracts for airships in trans-ocean operation. A measure to accomplish that purpose failed of passage in the last Congress, after long hearings had developed much favorable sentiment.

Principal air mail developments elsewhere include the speeding up of mail between Toronto and Detroit with that of Transamerican Airlines to Chicago and Northwest Airways to Pembina, N. D., and by introduction of fast Stearman mail planes. Transit time between Toronto and Winnipeg is thus reduced from 36 to 19 hours. Mexico has assured support of air mail until Jan. 1, and special efforts are being made to provide for 1932. From Copenhagen comes the report that Norwegian Air Transport has been organized with the expectation of operating a trans-Atlantic air mail service from Norway next summer by way of the sub Arctic route, on the same course surveyed by the late Parker Cramer.

New airport rating

The revised airport rating regulations of the Aeronautics Branch introduces a new maximum rating for denoting size of the effective landing area. The rating ATA is one grade higher than the former maximum of A1A, the T indicating that the port has an effective landing area of 3,500 ft. in all directions (whereas 2,500 ft. were required under the 1) and that approach obstructions are such as to permit a 10 to 1 glide rather than 7 to 1 glide. Seaplane bases must have an effective landing area large enough to permit a 5,500-ft. run in any direction to qualify for the T. The change is a concession to trends toward larger transports with high wing loadings and landing speed. New regulations promulgated by the Treasury Department regarding airports of entry state that they must qualify for at least the A1A rating.

The most comprehensive flying center ever built—the Air Corps Training Center at Randolph Field, San Antonio—now houses more than 200 planes and its first class of 200 students. The major part of the $25,000,000 construction program on the 1,900 acres of landing area and 500 acres of building space has been completed. Another important airport recently commissioned is the state field at Hillsgrove, R. I. Moscow dedicated in November its new 250-acre airport, which, so the Russian news agencies declare, is expected to have at once an average of 200 plane arrivals and departures daily. Discussions continue relative to the proposed movement of civil activities from Le Bourget, to a new non-military airport on the outskirts of Paris.

Scattered port construction

Further improvement of the Boston Municipal Airport has been assured with the awarding of a $500,000 contract for dredging, filling and bulkhead construction. This is expected to provide an area large enough to qualify for a No. 1 rating. The new $100,000 union passenger terminal, for patrons of all airlines using the field, was opened at the Chicago Municipal Airport Nov. 15; bids have been invited for the $50,000 two-story administration building and passenger terminal to be erected at Candler Field, Atlanta. The second of six new steel and concrete hangars for Pan American's Miami base has been started. Each measures 140 ft. square and costs about $60,000.

Of great importance to the development of the general airport map is the recent recommendation to the convention of the National Association of Railroad and Utilities Commissioners at Richmond by its committee on service of public utility companies that states should contribute directly to airway development by: 1, wisely providing flexible legislation; 2, providing and improving landing areas (either emergency or regular); and 3, introduction of instruction in aeronautical theory in public schools. The report pointed out that state gasoline taxes may be used for financing such efforts, and that cost of upkeep of a modern airport is trivial in comparison with high-grade highways.

A conference on airport affairs was held Oct. 13 to 14 at Tulsa under auspices of the south-central regional organization of the Aeronautical Chamber of Commerce.

Personnel changes

Brig.-Gen. Benjamin D. Foulois will become Chief of the Air Corps Dec. 15, succeeding Maj. Gen. James E. Fechet. General Fechet will retire Dec. 31, after 33 years service in the Army.

Haven B. Page, of Air Associates, has retired from that concern and will specialize in aviation insurance in the firm of Aviation Protection, Inc., of which he has been a director since 1928.

W. Laurence LePage, formerly chief engineer of the Kellett Aircraft Corporation, has been named vice-president in charge of engineering.

Willis C. Brown has resigned as director of sales and service for Continental Aircraft Engine Company, Detroit. He will be engaged henceforth on other work, non-aeronautical, for Continental Motors Corporation.

F. Warren Oakes, Jr., assistant to the president, has been elected vice-president of American Airways.

Barney Graves, vice-president and general manager of the Yellow Cab Company, Philadelphia, is now manager of ground transportation for Century Air Lines.

William F. Young, secretary of the National Air Race Contest Committee for four years, has been placed in charge of aviation sales activities for the B. F. Goodrich Rubber Company on the west coast.

The Marquess of Londonderry, newly appointed British Air Minister, who was under-secretary for Air in 1920 and 1921, steps into a place that for about eight years was occupied by Lord Thompson and Sir Samuel Hoare in alternation. Sir Philip Sassoon, under-secretary for Air under Sir Samuel Hoare who is now Secretary for India, becomes under-secretary again.

Statistics of the Month

Material supplementing the statistical issue, AVIATION, March, 1931, appears regularly each month. Page numbers in the statistical issue are given.

ACCIDENTS IN CIVIL AIRCRAFT OPERATIONS

(January to June, 1931)

	Scheduled operations	Miscellaneous flying
Miles flown	20,304,430	43,282,595
Total accidents	61	991
Accidents per million miles flown	3.00	22.90
Accidents involving fatal injuries	5	109
Fatal accidents per million miles flown	0.246	2.52
Passenger-miles flown	47,501,901	.....
Passenger-miles per passenger fatality	5,277,989	.....

A DECREASE in fatal accidents in both scheduled operations and miscellaneous flying is reported by the Aeronautics Branch of the Department of Commerce in its analysis of accidents during the first six months of 1931. Mileage flown in scheduled air transport operations during that period increased by 20 per cent over the figure for the previous year, but fatal accidents dropped from 0.35 to 0.25 per million miles flown. There was an increase, however, in accidents of all types, of from 2.60 per million miles flown last year to 3.00 in 1931. Only nine passenger fatalities occurred in the first six months of 1931, making the number of passenger-miles per passenger fatality a good deal more than double what they were in the first half of 1930. This in a period when total passenger-mileage, a passenger-mile being equal to one passenger flown one mile, was almost 10 per cent less than it had been for the early part of the preceding year.

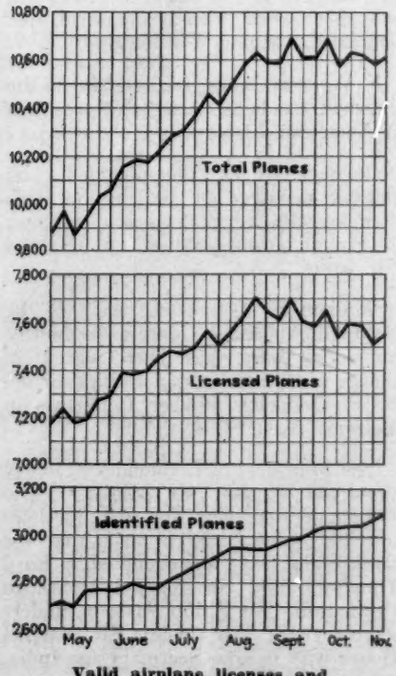
Similar tendencies are observable in miscellaneous flying, which includes student instruction, experimental flying, aerial photography, sight-seeing, crop dusting and exhibition flying, as well as the operation of privately owned planes for pleasure only. Fatal accidents per million miles flown in these operations dropped from 2.72 in the first half of 1930 to 2.52 in the same period of the current year. Accidents of all types per million miles flown, still about seven times more numerous than in scheduled transport operations, increased from 17.71 in early 1930 to 22.90 in the first six months of 1931. No figure for passenger-miles is available for miscellaneous flying, but if airplane mileage is used as a base, the number of miles flown for each passenger fatality is 709,551, about a third the number flown for each fatality in scheduled transport operations and slightly more than the rate for the Army Air Corps.

The analysis of causes of accidents shows them definitely typical of the variety of flying involved. Miscellaneous causes among which weather predominates took responsibility for 32 per cent of the accidents in transport operations, while 53 per cent of those in miscellaneous flying were due to personnel errors, practically all on the part of the pilot.

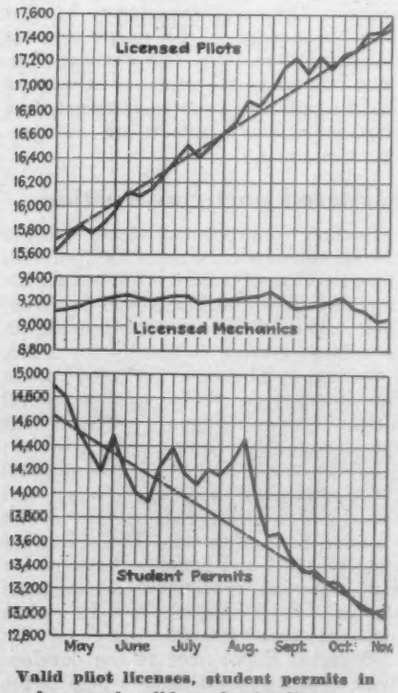
PRODUCTION AND LICENSING

(Page 136)

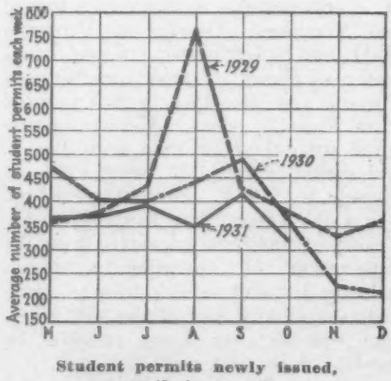
THE curve of aircraft legally approved for service, though still well above the 10,000 mark which was the high point



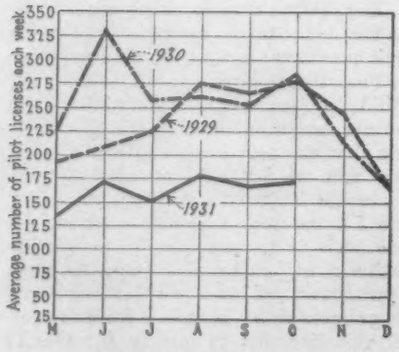
Valid airplane licenses and identifications



Valid pilot licenses, student permits in force and valid mechanics licenses



Student permits newly issued, month by month



New pilots licensed, month by month

last year, shows a slight downward tendency. This trend is more marked in the case of licensed planes whose curve, notwithstanding its tri-weekly peaks, has dropped at the rate of about ten planes per week during the past ten weeks. An increase in identified planes, however, maintained at an even rate, has served almost to counteract this decline.

THE totals of valid pilot licenses and student permits continue to follow with surprising fidelity the lines of general trend. On the basis of the average change during the early months of the year were drawn the broken lines to which the personnel curves have adhered so closely that the total number of licensed pilots and student permits valid is almost exactly the same as it was on the first of May.

THE average weekly issuance of both new pilot licenses and student permits for the month just past is as usual below the figures for the two preceding years. Though pilot licenses are being obtained at a rate some 35 per cent below those of 1930 and 1929, applications for student permits have fallen off to no very appreciable degree.

Makes of Newly Licensed and Identified Aircraft

(Third Quarter, 1931)

	Licensed	Identified	Total
Aeronca	20	...	20
American Airplane & Engine (formerly Fairchild)	4	1	5
American Eagle:			
American Eagle	2	1	3
American Eaglet	10	...	10
Amphibions Privateer	2	...	2
Bellanca:			
Skyrocket	1	2	3
Bird	16	...	16
Buhl:			
Buhl CA	...	2	2
Bull Pup	21	...	21
Cloude Coupe	...	2	2
Consolidated	17	...	17
Curtiss-Wright:			
Junior	91	1	92
Keystone	1	...	1
Kingbird	1	...	1
Moth	2	...	2
Sedan	11	...	11
Travel Air (biplane)	12	...	12
Travel Air (monoplane)	1	...	1
Cycloplane	2	...	2
Davis	2	...	2
Detroit Lockheed	5	...	5
Eaglerock	2	3	5
Fairchild (new company)	...	15	15
Ford	3	...	3
Great Lakes	...	20	20
Heath	...	3	3
Kellett Autogiro	1	7	8
Mono Aircraft	9	1	10
New Standard	1	2	3
Nicholas-Beasley	14	...	14
Pitcairn Autogiro	1	26	27
Rearwin	8	1	9
Spartan	1	12	13
Stinson:			
Fourth-place	35	...	35
Airliner	11	...	11
Taylor Cub	1	11	12
United:			
Boeing (single-engined)	3	...	3
Northrop (three-place)	5	...	5
Sikorsky (two-engined)	...	1	1
Sikorsky (four-engined)	...	2	2
Stearman	7	...	7
Vervilla	2	...	2
Viking	3	...	3
Waco:			
Open	27	2	29
Closed	13	...	13
Miscellaneous*	10	116	126
Total	378	231	609

*All makes having two or more planes licensed or identified are listed above.

FOREIGN ACTIVITIES

(Page 173)

FOR several years past it has been a difficult matter to get comparable statistics on the aeronautical activities of the various countries and on the amount of money actually spent on the development of air forces. No two nations have made up their budgets or rendered their accounts in exactly the same way.

That difficulty is overcome for the first time by the submission to the League of Nations in preparation for the forthcoming disarmament conference in Geneva of statements of military and naval material and expenditures all made up in accordance with a standard form. The figures for Russia have not yet been made public, but those for all the other great military powers are available, along with the data for a number of the smaller states.

In the table printed herewith the column of expenditures on material includes not only airplanes and engines but also armaments and miscellaneous accessories and equipment. Total expenditures include pay to the air forces, not regularly listed as part of the aeronautical appropriations in the United States. The tabulation of number of machines covers military types in service and those in immediate reserve service and also training and transport planes operated by the military services. In a few cases these non-combat types were omitted from the original reports made by the government, and in those instances, marked with an asterisk, their number has been estimated and added to the reported total.

Makes of Engines in Newly Licensed or Identified Aircraft

(Third Quarter, 1931)

	Licensed	Identified	Total
Aeronca	20	2	22
American Cirrus	1	35	36
Ansani	...	6	6
Continental	31	24	55
Cyclomotor	2	...	2
Ford	...	15	15
Genet	14	...	14
Heath	...	7	7
Heath-Henderson	...	10	10
Henderson	...	18	18
Hispano	3	...	3
Jacobs	...	7	7
Kinner:			
K-5	22	21	43
B-5	28	...	28
C-5	2	...	2
Lambert	1	1	2
Lambert Velie	...	3	3
Lawrence	...	4	4
Le Blond	1	4	5
Le Rhone	...	2	2
Lycoming	45	1	46
Michigan Aero Rover	...	6	6
OX-5	9	12	21
Pratt and Whitney:			
Wasp	14	2	16
Wasp Jr.	3	...	3
Hornet	7	3	10
Szekely	131	6	137
Warner Scarab	19	...	19
Wright Aeronautical:			
Challenger	8	1	9
Gypsy	5	...	5
Whirlwind (165)	1	1	2
Whirlwind (240)	1	...	1
Whirlwind (300)	9	5	14
Whirlwind (220)	1	4	5
Miscellaneous (outboard)	...	31	31
Total	378	231	609

AIR MAIL AND TRANSPORT

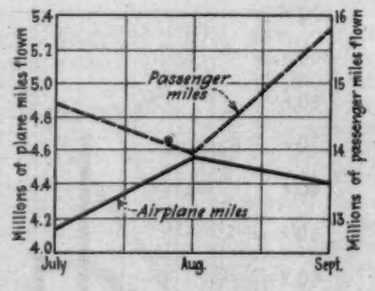
(Page 153)

IN THE face of decreases in traffic on railroads and steamship lines during the first nine months of 1931 of 20 and 30 per cent respectively as compared with last year, passenger traffic in air transport increased 7 per cent over its 1930 record. The Aeronautical Chamber of Commerce reports 348,507 passengers carried by airlines this year as against 327,211 during the same period of 1930.

Scheduled Air Transport Operations

(Third Quarter 1931 and 1930)

	1931	1930
Miles flown	13,123,908	9,097,900
Scheduled mileage	15,621,060	9,196,527
Passengers	172,364	134,232
Passenger-miles	44,438,904	34,565,191
Airmail poundage	2,465,601	2,190,307
Express poundage	296,105	81,022



Scheduled air transport, month by month

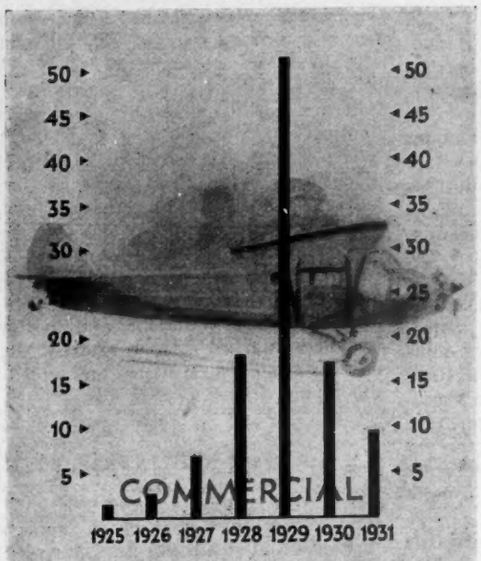
Army Air Corps Expenditures in Various Countries

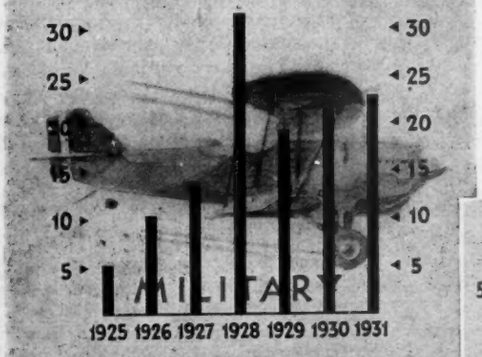
	Number of planes	Material expenditures	Total expenditures	Per capita expenditures
United States	2,351	$58,324,000	$110,070,000	$0.90
France	3,000	49,000,000	84,000,000	2.05
Japan	2,040*	.....	.....	.....
Great Britain	1,800*	39,200,000	94,000,000	2.12
Italy	1,660*	23,560,000	50,400,000	1.20
Rumania	799	5,410,000	8,850,000	0.49
Poland	700	4,265,000	8,760,000	0.29
Czechoslovakia	687	.....	.....	.....
Netherlands	321	2,230,000*	4,500,000	0.58
Belgium	308	.....	.....	.....
Norway	179	660,000	1,240,000	0.44
Finland	160*	.....	.....	.....
Sweden	157	1,485,000	2,590,000	0.42
Denmark†	78	440,000	760,000	0.22
Esthonia	74	.....	.....	.....
Austria	0	0	0	0
Germany	0	0	0	0

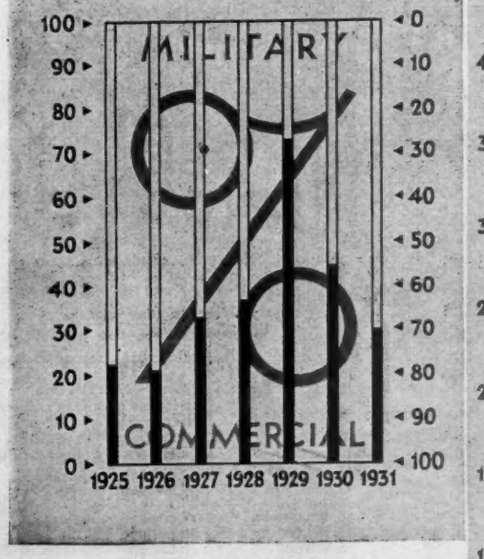
*Includes estimate of number of training and transport planes operated by the military services.

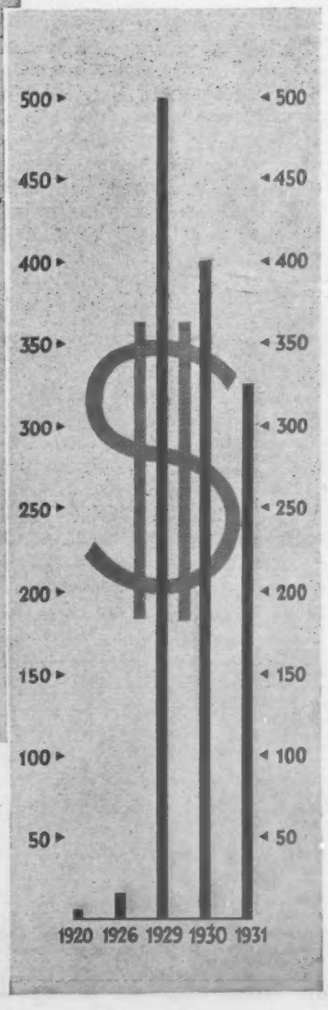
†Upon approval of a bill now being considered these figures may be changed to 24, $205,000, $380,000 and $0.11, respectively.

It will be noted that the U. S. has a lower per capita expenditure on air force than any of the other great powers, in spite of the generally higher scale of prices and expenditures here.









Above: Commercial and military production of airplanes and engines in millions of dollars, and per cent commercial and military of yearly totals. Right: Investments in the aeronautical industry in millions of dollars.

Where the industry stands

By Charles L. Lawrance

President, Aeronautical Chamber of Commerce of America, Inc.

THE condition of an industry may be gauged by what it produces—and sells.

In 1931, we estimate that the aircraft industry will produce 2,520 airplanes valued at $19,289,445 and 3,566 engines valued at $13,424,290—a total value of $32,713,735. And most of this equipment has been sold.

In 1927, there were produced 2,186 airplanes and 1,397 engines, valued at $21,055,532.

In 1928, the production was 4,761 airplanes and 3,252 engines, with a value of $49,648,197.

In 1929, the production was 6,034 airplanes and 7,378 engines, having a value of $70,053,130. Most of this very large production remained unsold at the end of the year.

In these figures is embraced the story of the expansion and contraction of the aircraft industry. From the standpoint of productive activity we are today back to about where we were in the first quarter of 1928, as shown in Table I. We have undergone some disillusionment. We have acquired much experience. And we have obtained and still retain certain tangible advantages, which, granted there is no serious deviation from our national aviation policy, hold forth to me the promise of distinctly better times.

But first let us examine further into the record of 1931. Of the 2,520 airplanes, which we estimate will be produced this year, 875, or 34.8 per cent, are military, valued at $12,847,625. Of the 3,566 engines, 1,866, or

52.3 per cent, are military, valued at $10,197,690.

Of 2,520 planes built in 1931, 1,645 or 65.2 per cent, valued at $6,441,820, are commercial. Of the 3,566 engines, 1,700, or 47.6 per cent, valued at $3,226,600, are commercial.

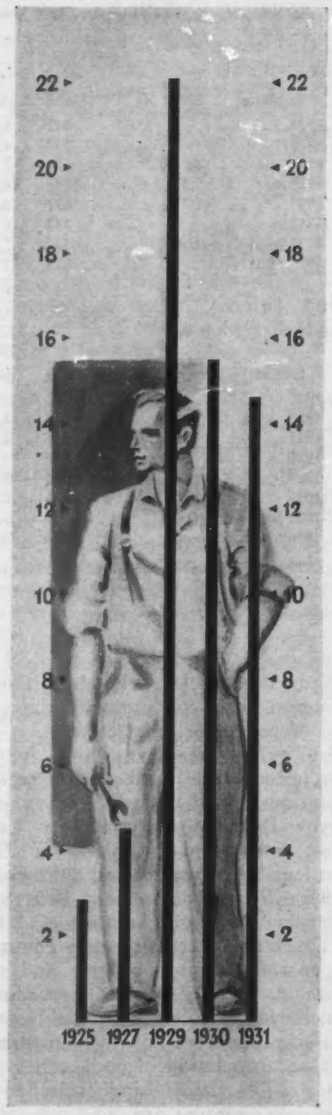
In other words, out of a total estimated production of $32,713,735 in 1931, $23,045,315, or 70.4 per cent, represent sales to the War and Navy Departments, and $9,668,420, or 29.6 per cent, represent sales to private and business owners, aerial service operators and operators of scheduled transport lines.

Our military sales in 1931 represent practically the final shipments under the procurement authorized by the Army and Navy Five-Year Programs—the Navy's quota having been completed and the Army's quota standing now at four and one-half yearly increments complete, with the last half of the fifth and final increment postponed.

Having learned, in 1929, the extravagance of building in anticipation of a commercial market which failed to appear, we spent most of 1930 in working off inventories, and in 1931 were generally disposed to build only on order.

Our commercial airplane production in 1931 we estimate at 1,645 units. Classified as to general types, according to the user, we find: 740 light airplanes, with a value, including engines, of $1,256,984; 658 larger private planes and equipment for business and aerial service use, with a value, including engines, of $3,310,976; 247 heavy transports with a value, including engines, of $5,100,550.

It is thus seen that the light types, while constituting 44.9 per cent of the total commercial production, represented but 12.9 per cent of the dollar value. The aerial service, business and private machines, constituted 40 per cent of the commercial total and represented 34.4 per cent of the dollar value. The transports, constituting but 15.1 per cent of the number of units, accounted for 52.7 per cent of the total value of our commercial sales.



Employees in the industry in thousands

No one knows how many millions of dollars were poured into the emergency aircraft industry, hastily created during the World War; but we do know that by 1920 not more than $5,000,000 capital investment remained. In the next six years, we estimate that this had grown to $15,000,000. In 1929, when the boom was at its height, it is believed that $500,000,000 was invested in our total aeronautical fixed establishment, including building sites, structures, machinery, tools and airports. In 1930, perhaps $100,000,000 had been liquidated. By 1931 the capital investment had been further reduced to an estimated total of from $300,000,000 to $350,000,000.

In 1925, 44 plants were listed as airplane factories and four as engine factories, as shown in Table II. In 1929, there were listed 101 plane factories and 52 engine factories. In 1931, the list declined to 82 plane factories and 31 engine factories, of which, however, only 46 of the former and only nineteen of the latter plants were even nominally active.

In 1925 the plane and engine plants employed a total of perhaps 3,500. In 1929, the personnel totalled 22,000. In 1931, the number had decreased to 14,650 operatives, of whom 75 per cent were engaged in military construction.

In November, 1918, when the war-time aircraft industry was approaching its maximum, our plants were producing planes at the rate of 21,000 per annum, while engine production was at even a higher peak. In 1925 the productive capacity of the industry was 1,200 planes, though only 715 were actually built. In 1929, when our commercial boom production facilities were approaching the zenith, we were turning out airplanes at the rate of 6,000 and engines at the rate of 7,000 a year. In 1931, we estimate that we will build a total of 2,520 planes and 3,566 engines. Yet our production facilities, in so far as structures, tools and machinery are concerned, remain, in 1931, practically what they were in 1929.

From 1903 to 1914, there was virtually nothing but experimental flying. From 1914 to 1917, when we entered the World War, a few plants were producing aeronautical equipment for the Allies. The period 1917-1918 marked the creation and 1919-1920 the liquidation of our war-time aircraft establishment.

By 1922 aviation had sunk to what appeared to be the lowest point possible to reach without disappearing. We lacked a continuing military procurement policy. Disastrous attempts were made to operate transport lines with obsolete equipment. The country was full of barnstormers flying surplus military planes, doing stunts and impressing the public further that flying was a trade suited only to daredevils, that an airplane was outrageously costly, and that even to ride in one was heroic. The popular idea of aviation was that it was a military adjunct. There was no financial incentive to encourage commercial aviation and no legal protection once operation was begun. There were virtually no airports, save a few military fields, and absolutely no airways or aids to aerial navigation. From an engineering standpoint, we had progressed no further than two

In any plan for world-wide reduction of armament it must be remembered that the aeronautical industry in the United States is deeply involved in the decisions made. Our industry seeks support from the military services to preserve its identity. It is the responsibility of the services to preserve this identity, first for its commercial value in time of peace, later for its absolute necessity in the event of war.

types of service planes and engines developed during the war.

From 1918 to 1923, the aircraft industry and our air defenses were made the subject of a number of investigations. Not all of these inquiries were friendly. Outstanding, however, among the constructive observations were those made in 1923 by the Lassiter Board of the War Department, and in 1924 by a Special Board of the Navy Department.

The Lassiter Board, which included representatives of the General Staff, stated: "The aircraft industry in the United States at present is entirely inadequate to meet peace and war-time requirements. It is rapidly diminishing and under present conditions will soon practically disappear." It was the opinion of the Lassiter Board that a continuing procurement program extending over a period of ten years would be most helpful.

The Special Board appointed by the Secretary of the Navy, reporting in 1924, found that "the aviation industry is in a very unsatisfactory condition."

This Board, which, like the Lassiter Board, did not include a single representative of the industry, listed as contributory causes, first, the letting of airplane contracts by competitive bidding; second, a lack of continuity of production; and third, the destruction of capital in the industry.

Congress next took a helpful step. The Select Committee of Inquiry into the Operation of the United States Air Services, otherwise known as the Lampert-Perkins Committee, sitting in 1924 and 1925, recommended that "not less than ten million dollars should be spent annually for the War Department and a like sum for the Navy Department for the procurement of new flying equipment, constructed by the civilian industry." Purchases, the Committee's report observed, should be based on a continuing program. Recognition by the government of proprietary rights of design in the construction of planes, engines and accessories also was urged.

Largely as a result of the Congressional inquiry, President Coolidge appointed an Aircraft Board, headed by the late Senator Dwight W. Morrow. The Morrow Board, in its report, complemented the conclusions of Congressman Randolph Perkins and his colleagues, with respect to assistance to the aircraft industry and stressed the necessity for the adoption of a policy of continuity in the purchase of aviation equipment. Out of the tangle of conflicting and controversial testimony, as given before the various preceding investigating boards or committees, the Morrow Board, late in 1925, evolved a national policy.

Our air transport system had its beginnings in the passage in February, 1925, and amendment June, 1926, of the Kelly Contract Air Mail Law, and the enactment in April, 1930, of the McNary-Watres Act, whereby air mail carriage is used to stimulate the carriage of passengers and express.

Our military policy, which in the main pursues the spirit of the recommendations of the Army, Navy and Morrow Boards and the Perkins Committee, dates from the middle of 1926, when legislation was passed authorizing the Five-Year Procurement Programs.

Our lawless flight became legal and our adventurous cross-country commercial operations more orderly and safe when, in 1926 also, the Aeronautics Branch was established in the Department of Commerce for the encouragement and regulation of civil aviation.

May 20-21, 1927, Lindbergh flew to Paris. Without in any way detracting from the significance of that immortal achievement, I believe it is truthful to say that the world, amazed that such a thing could be, emulated Lindbergh in fancy and saw the heavens filled with commerce. It was as if a meteor, flashing into our vision, had for a moment illumined the vault of the sky, giving us a glimpse of what could be seen, understood and utilized generally only after patient research, experiment and practical education.

However that may have been, our industry was under way; the boom was on; all else was forgotten. If some of us had our doubts, these doubts were swept aside by popular enthusiasm. And it probably occurred to none of us, either in the industry or out, that while we thought aviation was booming business, what really was happening was that the general business boom, world-wide in its surge and scope, was carrying aviation with it.

Without this tremendous impetus, beyond our control and certainly at the time beyond our knowledge, it is now obvious to me that aviation would never have been promoted to such unsound heights, and likewise would never have suffered so severely when the general depression came.

Let me now revert to the four obvious markets for aircraft: private, aerial service, scheduled transport, and military.

The air "flivver" has never appeared, except as an engineering experiment, but private flying is a fact. In 1928, 1,500 planes flew 12,000,000 miles in the hands of individual owners; 3,125 flew 25,000,000 miles in 1929, and 4,974 flew 40,000,000 miles in 1930. This year we estimate that 3,750 are in active use, and in twelve months will have carried their owners 30,000,000 miles.

How rapidly the 3,750 private planes will be increased in number depends largely upon advanced engineering and,

Table I: Airplane and Engine Production

	Military			Commercial		
Airplanes	Units	Value (dollars)	Unit value (dollars)	Units	Value (dollars)	Unit value (dollars)
1925	447	5,174,025	11,575	268	1,499,634	5,595
1926	532	6,154,708	11,569	604	2,716,319	4,497
1927	621	7,528,383	12,123	1,565	6,976,616	4,457
1928	1,219	19,066,379	15,641	3,542	17,194,298	4,854
1929	677	10,832,544	16,221	5,357	33,624,756	6,276
1930	747	10,723,720	14,355	1,937	10,746,042	5,547
1931 (seven months)	542	7,958,567	14,683	1,158	4,534,875	3,916
1931 total (est.)	875	12,847,625	.....	1,645	6,441,820	.....

	Military			Commercial		
Engines	Units	Value (dollars)	Unit value (dollars)	Units	Value (dollars)	Unit value (dollars)
1925	....*	.....*	.....*	....*	.....*	....*
1926	842	4,080,571	4,846	....*	.....*	....*
1927	1,397	6,550,533	4,689	....*	.....*	....*
1928	2,620	12,407,920	4,735	632	979,600	1,550
1929	1,861	8,600,530	4,621	5,517	17,895,300	3,243
1930	1,841	10,823,423	5,879	1,925	6,255,493	3,249
1931 (seven months)	1,166	6,372,555	5,465	1,570	2,980,046	1,898
1931 total (est.)	1,866	10,197,690	.....	1,700	3,226,600	.....

*The war supply of OX-5 and Liberty engines were in use almost exclusively at this time, and were used on commercial planes to some extent in 1928.

Table II: Manufacturing Facilities

Airplanes	Plants listed	Actually doing business	Employees
1925	44	..*	2,701
1926	62	..*	.....†
1927	70	..*	4,422
1928	78	..*	.....†
1929	101	92	16,105
1930	100	67	12,000
1931	82	46	11,500

Engines	Plants listed	Actually doing business	Employees
1925	4	..*	.....†
1926	5	..*	.....†
1927	6	..*	.....†
1928	17	..*	.....†
1929	32	30	5,977
1930	34	28	3,500
1931	31	19	3,150

*No data available but probably corresponds closely to number listed, as business was expanding. †No data available.

probably, lower prices, together with uninterrupted development of our federal airways and the maintenance of aids to navigation. The states must supplement the federal program with airports, airways, lights, and weather data for flying within their boundaries. It seems clear to me also that private flying will increase only to the degree that patronage of the scheduled transport system increases. As the body of the public intelligently acquainted with the advantages of air travel is enlarged, so will be enlarged the prospective market for the sale of private planes.

Table III: Miscellaneous Aerial Service Operations in the United States

	1925	1926	1927	1928	1929	1930	1931
Number of planes	676	969	768	489	7,408	5,324	4,824
Passengers	205,094	380,201	476,724	526,203	2,995,530	2,621,769	1,917,540
Miles flown	4,640,672	7,656,492	8,341,517	8,411,889	104,336,560	95,959,645	74,772,000
Employees	931	1,537	1,674	1,988	20,944	12,283	3,839
Operators	262	420	357	268	800	600	349

From 1919 to 1924, the gypsy flier had his day. By 1925 most of the reckless itinerants had disappeared and the more substantial ones had become fixed base operators—the forerunner of specialized aerial service. From 1925 to 1928, there was substantial growth, so far as the carrying of passengers or the performance of salable services were concerned. In 1929 the public, which was seeing "big money" in aviation, as well as in almost everything else, raised the number of planes in aerial service (as compared with 1928) from 489 to 7,408, carried 2,995,530 passengers instead of 526,203, flew 104,336,560 miles instead of 8,411,889, and put 20,944 people instead of 1,988 on the payrolls. The sky was the limit.

But aerial service, for all its imaginative expansion, has reluctantly relinquished its gains. Passing over 1930 to 1931, we find that we now have (in contrast with 1929) 349 operators instead of 800, that planes in commission number 4,824, that 1,917,540 passengers will have been carried 74,772,000 miles, and that 3,839 employes will be doing the jobs that 20,944 were being paid for in 1929, as shown in Table III.

Development of the aerial service market for the industry depends on improved engineering, greater pay load efficiency, lower initial and operating costs, and, most emphatically, not only on the maintenance of the federal airway program, but also upon the provision by the states of aids to navigation for intrastate flying.

On a certain day in December, 1903, only one man in the world had successfully flown in an airplane.

In 1926, the first full year of our contract air mail system, 5,782 passengers were carried. Year by year, since then, the number has progressively increased: 12,594 in 1927, 52,934 in 1928, 165,263 in 1929, 385,910 in 1930, and, it is estimated, 400,000 in 1931. From 433,649 lb. in 1926, air mail has increased to an estimated poundage of 8,965,000 in 1931 and air express from 6,467 lb. in 1926, to an estimated 675,000 lb. in 1931. In 1926, nineteen operators employed 527 persons, utilized 95 planes and flew 2,025,824 miles on schedule. This year we estimate that 42 operators employ 7,000 persons, utilize 753 airplanes and fly an estimated total of 42,653,000 scheduled miles. Complete statistics, showing the growth of the air transport branch of the industry are given in Table IV.

I am convinced of two things:

First, that within a few years all of the first class mail and the bulk of urgent express will have to move by air because the public will demand it.

Second, that the average growth of the last few years indicates it is only a matter of mathematics and time until most of the passenger travel, where speed is a factor, will be by air; the public will insist upon it.

How long? Certainly not in 1932 or 1933. Air transport is now in its most critical stage. Remove from it the contract air mail, deprive it of the federal airway system and aids to navigation, and it will collapse. Deviate severely from our present policy, and its growth will be retarded. Here again engineering is imperative. Here again experimentation, always costly, is inevitable. Granted undisturbed continuance of indispensable federal assistance for a few more years and the system will establish itself upon a sound basis, performing an economic service to the public and aiding the production end of the industry by purchases of equipment and by creating an ever-widening circle of air transport patrons from among whom will come the aerial service customers and the private owners of the future.

This brings us once again to the military. For all my optimism, I cannot forget that in 1931, 70.4 per cent of the total value of our entire airplane and engine production is military, and that 75 per cent of the individuals on our payrolls are engaged in military work. I know that engineering is vital to our progress and that it is prohibitive in its cost unless it can be stimulated by military production. I know that without engineering, cheaper, safer and more efficient aircraft cannot be obtained. And I know that, without such improved aircraft, air defense falls short of its responsibility and commercial aviation cannot be expected to become a great and profitable industry.

Early this year it was my privilege to present a statement to President Hoover, in behalf of the aircraft industry. In this statement we said:

"It is our desire to develop aircraft primarily as vehicles of peace.

"Notwithstanding the possibilities which aviation offers for the good of humanity, we recognize that until peace is universally practicable, aircraft will occupy an increasingly important place in national defense.

"The aircraft industry—manufacturing and operating—is essential as a source of supply to the air defenses of our country."

Aviation cannot be dissociated from our national defense. Our national defense is now involved with the general problem of unproductive and excessive armaments, an answer to which is being sought by the world and by each of us individually as well. As an individual and also as the spokesman for the aircraft industry, I feel that it is proper for me to observe:

Any plan for the reduction of American air defenses in agreement with foreign powers, must, out of justice to us, recognize the fact that the fundamental concept of aviation held in the United States is radically opposed to that which we believe is held in some other countries. We regard aircraft as servants of commerce; others regard them as weapons of destruction. We ask support from the military for the aircraft industry in order that it may be established upon a permanent commercial basis; others subsidize commercial operations to achieve a military end.

We know where the aircraft industry is today; where it will be tomorrow, and how long will be required before we can achieve our objective as a business primarily commercial, but ever at the service of our country in time of emergency, I will not even hazard a guess.

Table IV: Scheduled Air Transport Operations

	1926	1927	1928	1929	1930	1931 (seven months)	1931 (estimated)
Planes	95	144	294	619	637	753	753
Passengers	5,782	12,594	52,934	165,263	385,910	231,925	400,000
Air mail	433,649	1,101,404	3,632,059	7,096,930	8,005,201	5,325,188	8,965,000
Express	6,467	12,495	35,376	197,538	286,798	464,590	675,000
Scheduled miles flown	2,025,824	3,922,304	10,472,024	20,242,891	28,833,967	22,455,878	42,653,000
Employees	527	840	1,740	4,430	6,350	6,947	7,000
Number of operators	19	24	32	27	35	40	42

Racing rules and handicap races

By Edward P. Warner

THE mere mention of the word "handicap" is a sure way of starting an argument in any group of pilots with racing experience. It is sure to call forth a string of reminiscences of unhappy experiences with incompetent handicappers, with prejudiced or unfair handicappers, with handicapping formulas the working of which escaped human comprehension, and with similar afflictions without number. The vehement debates and recriminations that attended on the Derby from Los Angeles to Cleveland at the National Air Races this year were in no sense unique. They were merely typical. Merely typical, also, was the view of the gentleman who loudly inquired, at intervals in one of the post-Derby discussions of the event: "Why have handicaps? Why not just get a gun and rob a bank?" Handicapping is sometimes regarded as one of the black arts, with the figures determined by abstruse researches in higher mathematics or by shaking dice. It is sometimes denounced as a branch of racketeering. In Great Britain practically all racing is on a handicap basis, and has been for eighteen years. The handicapping leads to close and interesting contests, and no one would think of abandoning it. In America, where it has always been in bad repute, its standing among the racing pilots reached a new low during the 1931 Derby.

I have always believed that handicap racing can be made fair and interesting and conducive to the improvement of the standards of airplane design and piloting technique. I have refused to admit that a class of competition which could be worked with perfect satisfaction to all concerned in Great Britain was beyond the capacity of Americans to operate. In spite of a wealth of sad experience in the past, I am still prepared to argue the question. I still believe that past failures can be explained, and that they need not be repeated.

Three kinds of handicapping

Broadly speaking, there are three kinds of handicap events. The simplest, and the type that is characteristic in Great Britain, is that in which the handicaps are assigned very much as in track sports, golf, or polo. An individual or a committee does the handicapping, and he or they are responsible to no earthly power. When they speak, the last word on the subject has been said, and there is no protest. They are under no obligation to reveal to anyone the methods by which they arrive at their decision. The fundamental necessity in applying that system is of course the finding of a handicapper or committee who can be considered as free from direct commercial interest or personal prejudice and who will command general confidence. Its greatest advantage is that there can be no formal protest. Every pilot knows under what conditions he is competing, and if he doesn't like the conditions or doesn't trust the handicapper he has the option of staying at home. In Great Britain the handicapping was done for a number of years by Rupert J. Goodman-Crouch, now resident in the United States, and there is no record that anyone ever remained aloof from competition because of unwillingness to submit himself to Mr. Goodman-Crouch's jurisdiction.

The second possibility is the use of a definite formula, involving certain measurable properties of the airplane. Again seeking analogy with other sports, that is yacht and motor-boat racing practice. It has frequently been applied to airplanes in Germany, and somewhat less frequently in Great Britain in connection with particular events of great importance, such as the King's Cup Race. It has been the subject of a great deal of discussion, but of no serious trial, in the United States. The essential of such a formula is that it should include only quantities that can be measured absolutely positively and that do not lend themselves to manipulation, or concealment, such as power, span, wing area, or piston displacement of the engine. Quantities especially inviting to deception, such as gasoline consumption and propeller r.p.m., should be rigorously avoided.

The third type of handicap combines the worst points of both of the others. It is the method used in a number of American events in the past, and specifically in the 1931 Derby. It is the method of handicapping by definite and pre-announced rules, so that anyone who believes that there has been a departure from them has just reason and ground for protest, but using rules which leave almost infinite possibilities for error or fraud. After the planes have been flown by the official test pilot and their speeds determined for purposes of handicapping it is absolutely impossible, unless a separate observer is appointed for each plane, to stay with it every minute from then until the end of the event except when it is actually under seal in an official hangar, to prevent changes being made which will increase the speed. With personal handicapping (the first of the three methods listed) the handicapper takes the prob-

ability of such alterations into account and shifts the handicap wherever he believes that they are being made. Under such rules as those used in this year's Derby no one has any right to change the handicap after the official test has been flown, and all that can be done is to attempt the impossible feat of guarding against any changes in the plane.

There are the three general types of handicap. For the third it is difficult to find any justification except as a device for stirring up a fight. The first and the second each have their place, but their places are quite different.

How to do it

The first type of handicapping frankly has no other objective than to produce an exciting race, exciting both for the competitors and for the spectators. It is best suited for comparatively short events, not of great individual importance, and not individually presenting a great amount of prize money. It is ideally adapted to the situation that exists in Great Britain, where very much the same group of pilots meet week after week in week-end meets at various fields around England. The handicapper knows all the pilots, their cornering ability and their racing judgment, and he keeps what a racetrack habituary would call a "dope-sheet," with individual records and estimates of the performance of all the airplanes and engines. The same procedure is equally well suited for use in the United States in an event which, like the National Air Races, continues over a week or more. With the same machines racing every day and handicaps revised daily, by the end of the fourth day a competent handicapper should have most of the entrants finishing under a blanket, to borrow another colloquialism from the ponies. From the point of view of the competitors the races will thereby acquire some competitive interest, the results will cease to be a foregone conclusion after the first half lap of the first meeting of a given group of machines, and the man who loses today will know that he is at least going to compete under different conditions tomorow and so have a new chance of winning. From the point of view of the spectator the races will become races, which will be a decided novelty. Instead of seeing all the machines start together and gradually spread out at a constantly increasing rate, with the ultimate winner leading by 100 yards at the end of the first lap, 200 at the end of the second, 400 at the end of the fourth, and so on, the visitor to the grandstand will see a group of planes starting off one by one at varying intervals and gradually converging until, if the handicapping has been properly done, they are all grouped most closely as they pass the finish line. There will be an end to the dominance of a whole group of class races by single machines, with that long sequence of parades around the course which were uniformly led by Benny Howard in 1930, and almost as uniformly by John Livingston this year.

"Handicapping is sometimes regarded as one of the black arts."

Handicapping by personal judgment is admirably suited for these short closed-circuit races. It would be totally unsuitable for a great single event (even though it is now used in the King's Cup Race in Great Britain), and specifically it would be a most undesirable method to apply to the cross-country derby, perhaps even more undesirable than the system used this year. For events of that type, the formula ought to come into its own.

Where the formulas come in

Personal handicapping can, and seeks to, equalize the chances of all the competitors, whether they be flying JN's or Lockheed Orions. No formula can do that. Mathematical handicapping is bound to discriminate in favor of the more efficient and against the less efficient. It is bound to penalize poor aerodynamic design, which is as it should be if racing is to be used to improve the breed of airplanes. Aside from the lack of excitement with unhandicapped races, they are objectionable in that they throw all stress on increasing the engine power and clipping the wings. Success in unhandicapped competition depends even more upon highwing loading and a low power loading than upon aerodynamic cleanness and efficiency. The stock machine of purely commercial type has no chance in such a contest, and every incentive is given to the development of airplanes that are expensive, uneconomical in operation, and unsafe. Those drawbacks of racing, at least, can be overcome by the use of the formula, and the man who has a machine of low power and of low landing speed, but of an originally good design, and who cleans it up carefully in preparation for the competition, can race with some hope of success against the man who is using several hundred horsepower to pull a tiny pair of wings and the pilot alone around the race course.

Formulas are innumerable, and some of them are very complex. In the King's Cup Race of several years ago the British used the load per foot of span as the basic quantity in handicapping. In the German seaplane competitions of 1926 a very intricate formula of several terms was employed. The more elaborate the form, the greater the accuracy that may be attained, but there is no formula to be had that so well combines accuracy with the highly desirable virtue of simplicity as the familiar system of taking maximum speed as equal to a constant times the cube root of the horsepower per square foot of wing area. The derivation of that expression has been given elsewhere (see, for example, AVIATION for January, 1931, page 56) and need not be repeated here. For purposes of handicapping it is convenient to change the formula by substituting piston displacement for horsepower, as power is one of those quantities that cannot be positively measured on the competing machine, and therefore leaves the way open for endless dispute, while piston

displacement can be readily checked in case of protest.

With that change the maximum speed for purposes of handicapping can be calculated by:

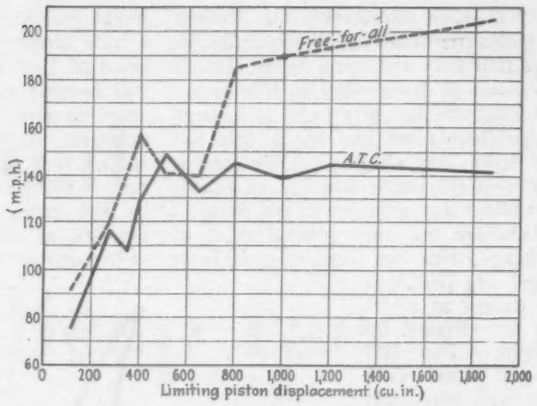
$$V = 100 \sqrt[3]{\frac{D}{S}}$$

where V is the maximum speed, D the piston displacement in cubic inches, and S the wing area in square feet. The application has been checked for a number of commercial machines, with the time that they would actually require to fly the course calculated from the maximum speeds as stated by their manufacturers in AVIATION's specification tables. It develops that with that method of handicapping a Lockheed Vega, a Privateer amphibion, a Wasp-engined Stearman, a Menasco-engined Gee-Bee, and a Douglas amphibion would all finish within 30 seconds of each other on a 25-mile course, although their starting times would be spread out over about four minutes by their handicaps. In a 2,000-mile derby the handicaps would run up to about six hours within that group of planes, but they should all finish within 40 minutes, barring navigational errors and mechanical troubles, and there would be no room left for protest over alleged failure to apply the rules, for no one can go wrong on wing area or cylinder volume.

So much for the systems of handicapping available and the conditions under which they do their best work. The two devices for equalizing the performance of fast and slow airplanes that offer most promise of success and freedom from rancor have never been given a fair trial in this country. They deserve it at next year's National Air Races.

To all handicapping proposals, and especially to any that involve a formula, one standard objection is made. It is always protested that they are too complicated for either the competitors or the audience to comprehend them. The people who hold to that theory either know very little about other sports than aviation, or they have an extraordinarily low opinion of the mental capacities of the aeronautical crowd. Horse races are handicaped by an elaborate system of penalties for victories and weights for age, requiring a good-sized pamphlet to contain the instructions for applying it, but almost any one at the race track can rattle off the technical jargon of the handicapping rules and explain the handicap events. Sailboats are rated and handicapped by a formula involving the square root of the sail area and the cube-root of the displacement, supplemented with pages and pages of structural specifications and penalties for excess of overhang, deficiency of freeboard, and almost every other modification of dimension, yet yachtsmen, most of whom are not engineers or mathematicians, get along very nicely.

A casual inspection of the crowd attending a six-day bicycle race does not suggest that most of them have studied calculus or taken degrees at universities, yet they assimilate without apparent difficulty or complaint the weird and wonderful system of lap scoring and penalization, far more involved than anything required in running handicap air races. Trotting races and motor boat races are run in heats, and the ultimate winner of the race, determined by an arrangement of point scoring, may not have won a single one of the heats. It would be possible to go on almost indefinitely. If it is really impossible to apply handicaps to airplanes because nobody can understand them, we shall have to put ourselves in the position of confessing that the followers of and participants in air racing are the dumbest sporting crowd that can be found anywhere. I, for one, don't believe that it is necessary to make any such confession.



Winning speeds at Cleveland and piston displacement

Racing by classifications

Logic has undergone a serious defeat in the failure up to the present time to make use of any reasonable system of handicapping in the National Air Races. It has suffered another body blow in the scheme of division of the racing machines into classes which has been current for the last two years.

Divisions have been made on the basis of piston displacement, and the smaller machines have then been allowed to compete in the larger classes, apparently on the presumption that increasing the size of engine always leads to increase of speed. In the free-for-all classes there is reason for that assumption, for machines built especially and exclusively for racing, and to carry no useful load except the pilot and the necessary amount of fuel, in general show increased speed with increased size and power of engine. For the classes limited to the holders of commercial licenses, and presumably intended to be limited to standard commercial products, the assumption makes no sense at all.

To show how far it is from corresponding with the facts, it is sufficient to plot the curve of the winning speeds in the various A.T.C. and free-for-all races at Cleveland this year against the limit of piston displacement in the various classes. The free-for-all events show a general, although by no means a steady, tendency to increase of speed with increasing piston displacement. In the 400-cu.in. class, which caught two or three of the specially-built racing machines, such as Moore's Menasco-engined Ryder, the speed was higher than at either the 500-in. or the 650-in. limit,—though there was no apparent reason why Moore should not have won those events with just as high a speed as he made in the 400-in. class. The 800-in. class brought in a new special racing machine, the San Francisco monoplane with the large Menasco, that produced a jump in speed of about 30 m.p.h. (It should be noted that all these speeds as plotted on the curves were taken from the official report and included the effect of a standing start and of the corners. On the average the true speed around a five-mile lap would be from 5 to 9 m.p.h. higher than those plotted here, the true straight-away speed from 12 to 20 m.p.h. higher.) The 1,000-in. class showed another increase in speed, as the Wasp Junior there became eligible, and brought in the special Gee Bee racer. There were no special racing machines built with engines larger than the Wasp Junior, and everything from there up was won with that power plant.

The curve of the A.T.C. race results tells a very different story. It starts low, for it is hardly possible to get much speed out of an engine of less than 200 cu.in. with anything except an ultra-racing type of plane with very high wing loading. It advances almost steadily up to a figure of 149 m.p.h., reached by Livingston's Monocoupe in the race for the 510-in. class. From there on the curve veers up and down, depending on weather conditions at the time the race was run and on how much competition Livingston found. The 510-in. race was actually the fastest of all the ten A.T.C. events, running up finally to 1,875-cu.in. piston displacement as a limit. While Livingston only won in his own class and in the two next larger, there seemed to be no reason why he should not have walked off with the 1,000-in. and 1,875-in. A.T.C. races with equal ease.

In short, the indication is that there is no necessary and natural increase in speed with increasing engine displace-

ment in true commercial or sporting airplanes after the piston displacement has reached 400 or 500 cu.in. The curves of speeds in the cabin-type races at Chicago in 1930 led to exactly the same conclusion. It is quite natural that they should. In general, economy must be at least a minor consideration in any airplane built for commercial use or for general sale to private individuals. In general, the machine is expected to be capable of carrying a reasonable useful load, and a load which will increase in proportion to power. And if the load increases in proportion to power, there is no reason why a large plane should be faster than a small one.

There are of course stock planes of high power which are faster than any of those that raced at Cleveland. Livingston's plane was probably good for about 165 m.p.h. on the straight, and the last issue of AVIATION's specification table includes eight machines with engines of more than 900 cu.in. piston displacement for which speeds of 170 m.p.h. or better are claimed. None of them happened to be competing in the A.T.C. classes. Nevertheless it remains true in general principle that if we are to consider the A.T.C. races as designed to test qualities of airplanes suitable for general service with reasonable economy, there is no reason to expect that the speeds in the highest powered classes will be much, if any, above those in the low-powered ones, and it will often happen, as it did this year, that an exceptionally clean machine with a small engine will sweep triumphantly through the whole program.

In short, the mere stipulation of piston displacement as a means of dividing up the machines in the A.T.C. classes is futile. The problem of class division is not easy, but something must be done if the larger machines are to get a fair chance against the super-sports type with medium-sized engine. The simplest possible device, and the most effective, would be the supplementing of the engine-size limit by a weight-limit. Suppose, for example, that it be provided that in these stock classes all competing machines must have a gross weight of at least 3 1-3 lb. for every cubic inch of piston displacement. The two and three-passenger planes with 300-hp. engines would then be eliminated. Most machines, except those of very high-power loading, would be limited to their own class, which is as it should be. Thus, the Monocoupe would be able to run in a 450-in. class, but not in anything larger. A Waco F, with the same engine, weighing about 280 lb. more than the Monocoupe, would be eligible not only for the 450-in. class but for the 600-in., —and so on.

What racing needs

The racing of airplanes, like the racing of other machines or the racing of horses, has three possible purposes: (1) to provide the excitement of sporting competition for the pilots; (2) to afford an exciting show for the spectators, and to arouse their interest in aviation; (3) to improve the qualities of airplanes. If any one of the three purposes is to be accomplished, and if racing at the National Air Races or elsewhere is to be anything more than a rather drab background for a colorful series of stunting exhibitions, the proposals outlined here seem to be the very minimum that can be considered for immediate adoption.

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A rear view mirror for the pilot

A NOVEL and useful addition to the pilot's equipment on the Model 100-A Pilgrim transport airplane, manufactured by the American Airplane and Engine Company of Farmingdale, N. Y. (AVIATION, November, 1931, page 654), is the installation of a rear view mirror in the emergency exit slide over the cockpit. The mirror, a double convex type, is mounted on a small trap-door set in the forward part of the slide within easy reach of the pilot without leaving his seat. It may be opened or closed at will, either in the air or on the ground, and a latch mechanism holds it firmly in either the open or closed position. When closed, the trap door lies flush with the outside surface of the enclosure, and its edges form a seal to prevent the leakage of rain water into the pilot's cockpit. Since the cockpit itself is up on a level with the top surface of the wing, the view to the rear afforded by the mirror is entirely unobstructed. By reason of its double curvature a remarkably wide angle of vision both horizontally and vertically is obtained, making it unnecessary for the pilot to turn the plane around on the ground before taking-off to see if planes are about to land behind him.

A view of the pilot cockpit of the Pilgram 100-A transport showing the rear view mirror mounted in the roof. Note also the arrangement of entrance door and instrument board.

Air express possibilities in the United States

By
Monte C. Abrams

Aviation

A motorcycle sidecar collects and delivers parcels carried by Air Ferries, Ltd.

DURING the latter part of 1929 and the early months of 1930 the writer, acting in the interest of a large banking group, made an extensive survey covering 26 of the principal cities of the country to determine the extent of the interest on the part of merchants and manufacturers in the establishment of a countrywide air express system. Not only were the cities sufficiently widespread geographically, but the individual establishments visited in each were sufficiently diversified to cover a wide range of shippers' requirements. Shipping clerks, merchants, and business executives were questioned as to their reaction to the establishment of a countrywide express service which would be able to distribute their goods to practically any part in the United States at rates not over three times those charged by the railway express facilities. Many of the industries contacted were definitely and actively interested in a properly set-up express service. It was estimated that approximately 5 per cent of the goods which are being shipped by other means might reasonably be expected to travel by air if proper facilities were available. [This figure has been seriously criticized in some quarters on the ground that even such a relatively small percentage of the total shipments could not bear the increase in rate specified.—ED.] Whatever the exact figures may be, there is little doubt but that there is a definite field in the transportation picture for a unified express system.

What can go by air

To estimate properly the possibilities of air express in the United States it is necessary to make a broad survey of the field to establish in a general way the classes of goods which lend themselves to shipment by air. Looking first at both extremes, it is obvious that for individual shipments of small parcels and packages (those not exceeding 50 lb. in weight, and not exceeding 84 in. in length and girth combined) the air express will be in direct competition with the air mail, the choice depending upon comparative rates and the availability of adequate insurance; and that economic considerations will rule out air shipment of heavy, bulk commodities such as stone, coal, and lumber. This leaves, however, a very extensive group of shippers who now forward their goods by rail express and by truck, but who may find it to their advantage to divert a certain proportion of their products to the airways. The short haul, high frequency type of service which is already in operation in several cities offers attractive possibilities to local merchants and distributors for prompt delivery of parcels to their customers. Over longer distances many factories will find profit in making up solid plane loads of their products to their local distributing points. Bulk shipments of perishable goods, such as live stock, cut flowers, frozen fruits and vegetables will undoubtedly open up markets for such products which are unavailable today due to the limitations of the slower forms of surface transport. Certain of the more important and more interesting possibilities in this direction which came to light as the result of the surveys will be discussed in the following paragraphs.

As was intimated in a previous article ("Perplexities of Air Express," AVIATION, November, 1931) one of the most important uses for high speed transport is in the distribution of emergency spare parts needed for the repair of breakdowns. The automobile industry furnishes a good example, for its products are in widespread use, and repair parts are of a size and weight which may be conveniently handled by air. Detailed reports were prepared by two automobile companies after devoting a great deal of study to the matter on their own account. In order to give 24-hour parts service to practically every user of their trucks, the White Truck Company of Cleveland, Ohio, now carries an inventory of some $15,000,000 worth of parts, distributed in 32 principal service stations throughout the country. This firm calculated that it could, through use of a nationwide air express service, reduce the number of its stations from 32 to nine and the investment in spare parts from $15,000,000 to $5,000,000 and still be able to give the 24-hour replacement service. The average daily rail express shipments now amount to some 60,000 lb., and it is estimated that approximately this same volume of parts might be shipped by air under the proposed service at a considerable saving in money over the cost under the present supply system. The increase in rate would be offset by reduced expense in maintaining a larger number of servicing stations and in reduced inventory charges.

The Packard Motor Car Company estimated that approximately 11 per cent of its current rail express shipments could profitably be sent by air if the proper service were available. The average weight of the individual packages was approximately 50 lb. showing that this type of business could well be handled by current types of flying equipment. The average distance to which such parcels are shipped is 750 miles. The average cost of shipping by rail was $1.77 each as against approximately $5.31 by air. Although the consignee would pay an average of $3.54 extra on the cost assumptions here made, he would usually save at least one, and sometimes two, days in the time taken to repair his car. The experiences of these two companies are indicative of what could be expected of the motor car industry in general, and of manufacturers of motor boats, machine tools, oil well equipment, power plant equipment, and others of a similar nature.

Another possibility for the development of air express traffic is to be found in the changing character of national merchandising methods. With certain types of commodities the possibility for profit rests largely with low inventory, rapid turnover of stock, and the rapid stocking of merchandise that is in popular demand. An excellent example is found in the ladies' shoe industry. Where formerly buying was done once or twice a year, flooding the factories with orders at one season and causing shutdowns at others, it is now the practice for storekeepers to buy smaller quantities at more frequent intervals, taking their shipments by rail express to keep the stock fresh. Ten years ago 90 per cent of all shoes were shipped by freight, whereas today about the same proportion travels by rail express. It is not impossible that within another decade a material portion of all big shipments will be made by air express, including particularly all salesmen's samples and the first shipments of new models.

In this, the second article on the subject of air express, are outlined a number of the possible applications as based on a survey made by the author. Fundamental problems were treated in an earlier paper based on the same survey and on material from other sources. The opinions advanced in the first article were not essentially those of Mr. Abrams.

Manufacturers of other types of merchandise involving a distinct style hazard may find it profitable to make use of air express facilities. Outlying stores would be enabled to carry a line of samples only and would fill their orders by taking delivery by air express from some central distributing point from which the desired merchandise could be delivered to the customer without delay.

New and rapidly changing styles in dresses, furs, jewelry, hats, and other similar commodities may thus be kept up to the minute without risk of heavy inventory losses.

There are numerous other industries which may be expected to produce air express business when the idea has once been fairly accepted. Wheat is now purchased from flour mills on the basis of samples from the grain elevators, and the large baking companies now buy flour in carload lots on the basis of mill samples. Such samples average many hundreds of pounds daily throughout the country and now go by rail express. Air shipments of such samples might very easily save considerable time and reduce inventory. Business papers and "news-magazines" with a nationwide circulation may also find much use for the air express. The popularity of such papers depends to a large degree upon a rapid dissemination of the information which they publish. Newspapers also find reason for shipping certain editions to ontlying districts by air. Shipments of advertising matter, advertising plates, motion picture films, and similar commodities may also be expedited.

Frozen foods, particularly of the luxury type, may also contribute some volume to the air express. By rapid transport by air, it may be possible to obtain fruits, vegetables, sea foods, etc., in fresh condition in parts of the country where today such products are not available.

Another development which, although not promising any great volume of business in itself, is indicative of the new types of traffic which may be developed once an adequate air express service has been provided, is in the shipping by air of newly hatched chicks. During the first 36 hours after hatching, baby chicks go through a drying-out period during which time they require no food or water. They may, therefore, be shipped safely to destinations not over 36 hours from the hatchery. Experiments already conducted in Texas and California have shown excellent results from the shipping of chicks by air, thus ma-

A test load carried by Transcontinental & Western Air on their freight line between Kansas City and New York.

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terially increasing the shipping range of the hatcheries.

Present systems

Turning now from possibilities to actualities, an interesting example of what may be done with short-haul air express or package delivery service is being conducted on the west coast by Air Ferries, Ltd., of San Francisco. Organized primarily to carry passengers across San Francisco Bay, it undertook at the close of its first year of operation a program of air parcel service. After the first two weeks the volume of business grew sufficiently to offset the overhead chargeable to the additional equipment and personnel needed to handle the air express loads. During April, May and June of 1931, 35,000 lb. of express parcels were handled, and today the business is averaging 80 to 90 parcels a day with an average weight of 10 lb. each, approximating some 20,000 lb. per month. Prior to April of this year parcels were carried at the flat rate of 10 cents per lb., and no pickup or delivery facilities were provided. The new service, however, incorporates complete pickup and delivery services in the entire downtown area of San Francisco, Alameda and Oakland by means of motorcycle and sidecar equipment. Rates are on a unit basis, the charge being 25 cents for pickups, 25 cents for flying across the bay, and 25 cents for delivery, all for a 50 lb. unit. Parcels under 50 lb. pay the full rate and everything over pays the unit price for each additional 50 lb. or fraction thereof. Although the average parcel weighs 10 lb., one shipment which weighed 300 lb. was handled. Monthy rates are provided for users who wish to operate on a contract basis. Thus one package daily of 50 lb. or less will be carried by plane for $5 per month or will be picked up, flown across, and delivered for $15 a month. In addition to its own service, Air Ferries operates in conjunction with the Varney Airlines for the carrying of parcels and express between San Francisco and Sacramento. Emergency service connections are also provided to all the major airlines which use the San Francisco Bay Airdrome. The loads carried include automobile supplies, machine parts, shoes, hardware, milk, fish, newspapers, radio supplies, surgical supplies and jewelry.

Aside from the two lines mentioned above, a number of other organized air transport companies are carrying express matter on certain of their schedules. Working independently or in conjunction with such agencies as Western Union, Postal Telegraph, The Greyhound Lines, and the Railway Express Agency—American Airways, Boeing Air Transport, Kohler Air Transport, Ludington Airlines, Inc., National Air Transport, National Parks Airways, Northwest Airways, Pacific Air Transport, Pennsylvania Airline, Transcontinental & Western Air, Transamerican Airline, Western Air Express, and the Wilmington-Catalina Airline report a limited express business. In some cases exclusively express schedules are operated, but for the most part, express matter is simply carried in passenger airplanes on regular passenger schedules.

All indications point to an increasing interest in the problem, and it seems essential that some steps be taken toward the coordination of the several individual efforts that have already been started and the formation of a nation-wide system incorporating not only the necessary flying equipment but also adequate ground organization for pickup and delivery. The surveys have indicated that there is already a reasonable amount of business in sight for such an organization, and there is little doubt but that new possibilities for air express traffic will be uncovered with the establishment of an adequate type of service. It is going to be necessary, however, to establish a highly specialized traffic department to develop suitable types of traffic and to help control it, so that the flow may be as uniform as possible both in direction and volume. The problem of back-haul is very important in this connection, for it is obviously uneconomical to carry full plane loads in one direction and to fly empty machines on the return trip. As in any other transport operation, balanced two-way loads always spell profit. It will be necessary also to conduct an extensive educational campaign among shippers to indicate to them how they may best take full advantage of the air express service by proper wrapping and packaging of their goods in order to save weight and to insure satisfactory and safe handling.

Although it will not develop overnight, there is a place in the national transportation network for a unified air express system. Once it has been extablished, and, as reductions in the relative burdens of overhead and development in the design of equipment make it possible to lower rates, an increasing number of shippers will undoubtedly find it to their advantage to make use of the new facilites.

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Semi-cantilever landing gear

A SEMI-CANTILEVER landing gear of unique design has been developed by Theodore Woolsey for the O'Donnell taper-wing Waco, and has now had about ten months of actual service (including the 1931 women's cross-country derby). It consists of four steel strut members and two pairs of external brace wires. The wires take landing loads and the struts the drag and side loads. Each front strut carries vertical loads only and ends at the lower longeron, where it is pin hinged. These members are 1½x.095-in. chrome molybdenum tubing, heat treated to a tensile strength of 180,000 lb. per sq.in. The rear struts are of the same steel but are ⅞ in. in size. They extend past the lower longeron (to which they are pin hinged), and the upper end of each is braced to the fuselage structure by tie rods. These struts carry drag and side loads.

Both of the struts are welded to the stub axle in the axle mounting fitting. The landing wires extend from this fitting to the opposite lower longeron in each case. All shock absorption is accomplished by the tires alone, which are 21½x6-in. balloon type. The weight of this gear complete is approximately the same as that of the standard landing gear which it replaces, but the landing gear drag has been reduced considerably as the speed of the plane has been increased about 7 to 10 m.p.h.

The semi-cantilever landing gear on the Waco

The airplane's lighting problems

By D. C. Young
Nela Park Engineering Department
General Electric Company

The easiest way to design an electric system for an airplane is to copy automobile practice, but the easiest way is not always the best. Like other aeronautical engineering problems, the interior and exterior lighting of airplanes must be given individual attention if a satisfactory standard of efficiency and safety is to be maintained.

LIGHTING, as employed on present-day aircraft, in closely associated with safety. Depending upon the application, light provides safety for planes in the air or in making landings. In only one of four recognized uses for light on aircraft is it necessary for the operator to comply with Department of Commerce regulations; for the other three he can provide as much or as little light as he or his pilots deem necessary.

Far too often the value of light for a new and specialized service is underestimated, and the argument usually offered to substantiate the low standard provided on airplanes of today is that the weight of a more adequate electrical system is prohibitive. Logical as this argument may be, the important thing to realize now is the safety value of good lighting, and without further delay to encourage research and development of a more suitable electrical generating unit. The equipment now generally used is of relatively low electrical capacity and without regulation at the instant of peak load. It should be just the opposite. The aircraft operator, with an enormous passenger business in the offing, has not only the safety, comfort and convenience of the passengers to consider, but he must take the initiative in stating the essential requirements to be met by the equipment he uses.

We have the following recognized airplane lighting applications which determine the capacity of the electrical generating and battery equipment: navigation lights, instrument lights, cabin lights, and landing lights.

As in the case of the airplane itself, the design of the lighting system is a compromise between effectiveness and weight. Also, in the case of navigation and landing lights, any given system is effective or ineffective depending upon atmospheric conditions, for it must be remembered that a light plainly visible at a distance of several miles under favorable conditions may not be seen a thousand feet through heavy fog.

Navigation lights

Navigation lights show the approximate direction and attitude of flight of the plane on which they are installed to pilots of other planes. A green light marks the tip of the right wing, a red light the tip of the left wing, and a clear light the tail. Since, by location and design of the lighting units, only two such lights are ordinarily visible at a time, it is relatively easy to determine the line of flight of the plane. Fig. 1 shows the horizontal angles through which the various lights must be visible in order to comply with the Air Commerce Regulations. However, there is nothing in the regulations relative to the candlepower distribution of light which such units must provide; neither is the candlepower of the light source specified, but it is recommended that lamps of not less than 21 cp. be employed in each position. Such lamps meet the requirements adequately for clear weather signaling and produce the least interference in bad weather. Pilots seldom find it necessary to turn off the navigation light due to the annoyance created by the luminous fog or mist particles about the lighting unit. A very high candlepower lamp would doubtless create a bothersome halo at times, but the greater the wing span, the less troublesome the large lamps. Since extreme weather conditions (when little or no advantage by way of increased visibility is obtained through the use of higher candlepower lamps) are encountered only a small percentage of the time, the visibility normally provided by a 21-cp. lamp appears adequate. Serious consideration should be given to the use of two-filament lamps as a means of insuring a signal at all times. However, before this idea can be put into practice, a suitable lighting unit design as well as the recommended practice for wiring and switching must be worked out.

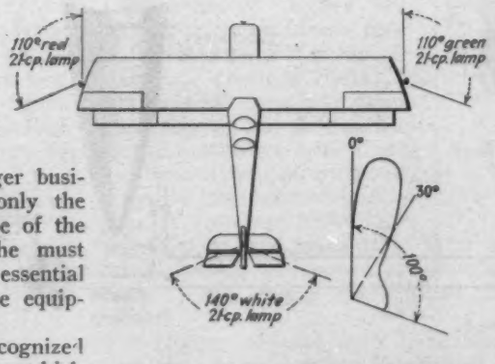


Fig. 1: Right and left navigation lights must be visible through an angle of 110 deg. from straight ahead, and the rear light through an angle of 140 deg. In each position, 21-cp. lamps are recommended. At the right is a more desirable light distribution for navigation lights. In the general direction of straight ahead, the highest candlepowers are projected; at no point within the 110-deg. zone is the candlepower less than 21. Such a distribution should not be difficult to obtain.

It is recommended practice to obtain the proper signal by means of colored cover glasses rather than gelatinous or celluloid compositions, thus eliminating fading and rapid deterioration of the cover, also a possible fire hazard. By means of enclosed masks or the opaquing of a certain area of the cover

glass, light is emitted through the required angles.

Temporary installations employing relatively low capacity dry batteries and low candlepower lamps should be avoided wherever possible, as experienced operators are finding it necessary in some instances to provide high candlepower marker lights in addition to the recommended navigation lights.

Instrument lighting

From the pilot's standpoint, instrument lighting has not been reduced to a standard form, and this is largely because of the fact that the light intensity inside the cockpit must bear a certain relation to that on the outside in order to eliminate eye strain and fatigue. After flying a few minutes at night with the eyes focused outside the cockpit, the pupils open wide to admit more light—a normal physical reaction over which the individual has little or no control. An occasional glance inside at a brightly lighted instrument panel is annoyingly glaring, and it usually requires a few seconds for the eyes to readjust themselves in order to see clearly. After this, another adjustment must be made in order to see again outside the cockpit. It therefore follows that more light can be tolerated inside the cockpit on bright moonlight nights than on dark nights. For this reason it is common practice to employ rheostats in the instrument lighting circuits. During the hours between daylight and darkness, it may be necessary to vary the lamps from full brilliancy to a very low value. "Luminous dials," therefore, have become popular, as one would expect, but they are not readily discernible at a glance because of their low brightness. The better practice in instrument design tends toward the use of dark field and white numerals, thereby reducing the light reflecting area of the dial which in turn makes for quick and easy legibility of the numerals thereon. Three or 6-cp. lamps if properly placed provide adequate instrument lighting and should be completely shielded from the pilot's eyes. Indirect lighting, as employed on most automobiles, is much to be preferred. Unfortunately it is usually true that instrument lighting has been added to airplanes as an afterthought, rather than made an integral part of the panel in the design stage.

The cabin

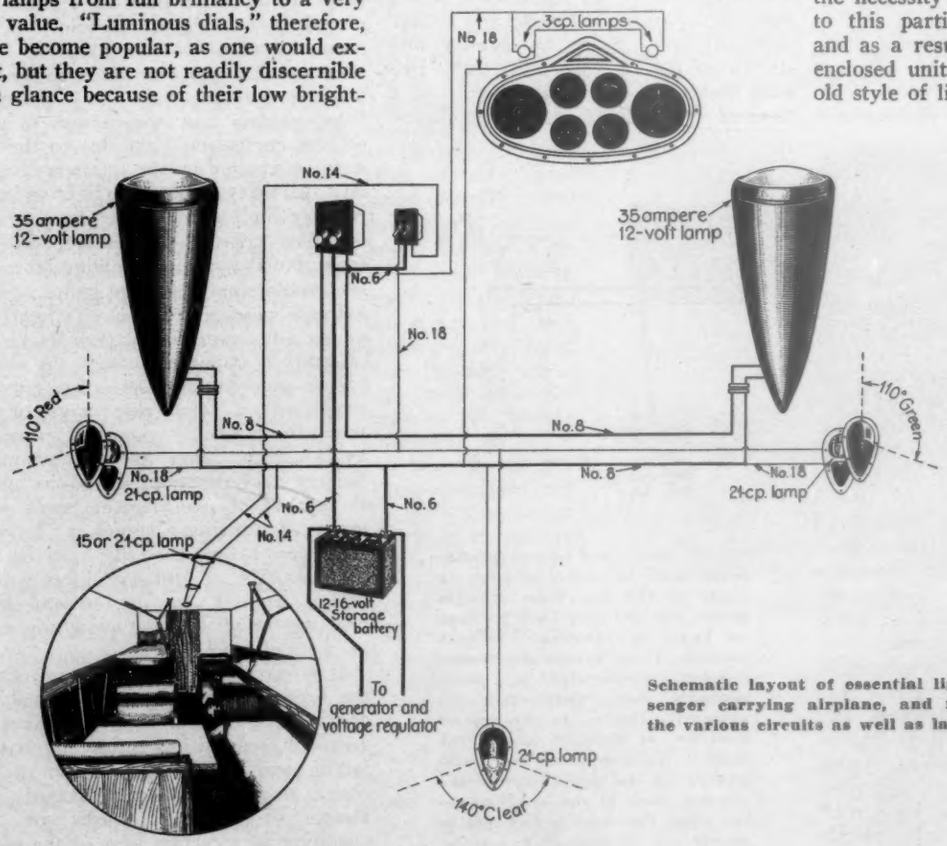
Cabin lighting is similar to motor-coach lighting as regards location and design of lighting units and size of lamps employed. While in the past there has been no particular demand for cabin lighting, the steady increase in the use of passenger planes for night travel places a new problem before the aircraft designer. Light inside the passenger compartment is necessary for reading and other purposes. Unfortunately such lights have the same effect on vision outside the plane as light inside a railroad coach—one simply cannot see outside very clearly with the interior lights burning. The reason is that the inside surface of the window glass reflects more light to the eye than comes through from the outside. As a rule, most air passengers want to see outside, and their doing so may be handicapped by one passenger who insists on having a reading light. This problem may be sloved by providing a few convenience outlets for "plugging in" reading lamps of the type that fasten to books. The light from such units would be far less annoying to other passengers than that from overhead or bracket units. Operating companies have in this application a problem to solve, not only as regards the style and location of lighting units, but when and how they shall be used.

Fifteen or 21-cp. lamps in enclosing units are suitable for cabin lighting. Fair illumination results are obtained by placing a unit over the back of alternate pairs of seats. Wherever possible, overhead or dome type units are recommended, although the candle or bracket type fixture may appear more ornamental. It is very important that the pilot have a switch in his cockpit to control all of the cabin lights when they interfere with his vision and safe handling of the plane.

Landing lights

The wing-tip variety of landing lights not only assist the pilot in effecting safe landings on improved airports, but are his only source of light for emergency landings. Every effort should be made to obtain the very best of this type of equipment and keep it in good operating condition.

Airplane manufacturers have realized the necessity for giving more attention to this particular lighting application and as a result we find that the wing-enclosed unit is tending to replace the old style of lighting unit which was attached to the wing. In this case, the lighting unit is mounted in the wing near the leading edge. A further modification of design provides a means for the pilot, through a system of levers, to swing the unit from its recessed position, thereby aiming it where desired. When not in use, the unit is retracted into the wing to reduce drag. In still another design, the lamp and reflector combination is pivoted behind the



Schematic layout of essential lighting equipment for a passenger carrying airplane, and recommended wire sizes for the various circuits as well as lamps for the several positions

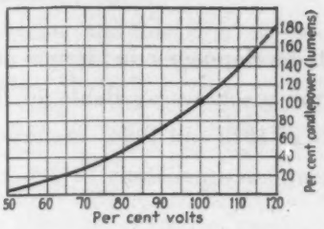


Fig. 2: Variation in lamp candlepower with variation in voltage

cover glass, which is built to conform with the contour of the wing.

The variety of light pattern such equipment should provide is as yet somewhat uncertain, and pending the time when lighting engineers and pilots can make definite recommendations as to candlepower distribution, the fairly narrow beam of old standing doubtless will continue to be used. The 12-volt 35-amp. lamp, adopted as a standard for the first night air mail flight, continues in use on those planes desiring the best lighting results. In a few instances, fluted cover glasses are used to spread the light beam through a slightly greater horizontal angle. This practice seems to have considerable merit, but is done at the expense of beam candlepower. If generally adopted, it may result in a need for still higher wattage lamps.

Following the practice on large planes of enclosing the lighting unit in the wing came a demand for extending the same practice into the small plane class. The thin wings developed the necessity for a small diameter lighting unit, and a lamp of reduced dimensions. Unfortunately, this step forced a reduction in lamp wattage, which accounts for the recent introduction to the trade of a new 12-volt 20-amp. lamp. These details are mentioned so that readers may know the reason for the introduction of the lower wattage lamp and so that they may not assume that small planes actually need less light than the large ones. No one would think of recommending a lower candlepower headlight lamp for a small automobile than for a large one.

Our European friends express considerable enthusiasm for a single 1,000-watt projector instead of one or two 420-watt units as used in America.

The power supply

Doubtless the weight of the power equipment more than anything else stands in the way of better lighting on planes as well as the use of additional electrical conveniences, such as heated clothes, radios, refrigerators, etc. As yet, however, the only general use of electrical energy is for lighting and operation of radio sets. American practice is to supply current from a storage battery installed fully charged prior to each trip or used in combination with a power-driven generator. The latter system is more generally employed, as it permits use of low capacity, light weight batteries. The same battery usually serves for both lighting and starting, and varies in rating from 35 to 65 amp.-hours. This is about one-half the capacity of batteries used in automobile service. Six-cell (12 to 16-volt) lead type batteries are universally used in America.

European practice employs a wind-driven generator mounted on the landing gear. Such generators supply a maximum of 1,200 watts at 24 volts—1,000 watts for the landing light, and 200 watts for navigation and cabin lights. The weight of the wind-driven generator equipment, installed, is approximately 52 lb.

Inadequate wiring plays havoc with an otherwise good lighting system. The curve in Fig. 2 shows the variation in lamp candlepower with voltage for typical airplane lamps. Obviously then, for a given lighting effect, it is false economy to save weight by skimping on wire size, permitting excessive voltage drop before the current reaches the lamp filament. By far the better practice would be to supply the proper voltage to a lower candlepower lamp. Sockets and switches of adequate capacity and proper design are likewise important features of a wiring system.

Iceboxes for rivets

A balsa wood box which uses carbon-dioxide for cooling

A rivet ice box used in the sheet metal department of the Boeing Airplane Company's plant at Seattle, Wash.

ABOUT a year ago E. H. Dix, Jr., and F. Keller, metallurgists of the Aluminum Company of America, announced a cold-treating process for delaying the aging effect on heat treated duralumin. The fact that age-hardening may be delayed by holding this material at temperatures around 0 deg. C. after heat-treatment, has important industrial applications, for heretofore it has been necessary to heat-treat materials subject to further deformation (such as rivets), in batches small enough to permit the using up of all the heat-treated quantities within one-half hour after quenching. By retarding age-hardening it is possible to heat-treat large quantities at one time, using them in manufacturing processes at any convenient time during the ensuing 24 hours.

A number of expedients have been tried for holding rivets at low temperatures, among which has been the use of iceboxes and mechanical refrigerating machines. A satisfactory device for this purpose for use with duralumin rivets has been worked out by several aircraft manufacturing plants, including the Buffalo-New York plant of the Curtiss Wright Company, the Boeing Airplane Company at Seattle, Wash., and the Naval Aircraft Factory in Philadelphia. It consists of an insulated box made of balsa wood (with a hard wood exterior case for protection purposes) large enough to hold a number of small metal boxes of rivets and a container enclosing a quantity of the solid carbon-dioxide known commercially as "dry ice." The size of the box naturally depends upon the number of rivets required daily, although its overall dimensions and weights must be qualified by requirements for portability. With this arrangement a rivet temperature of around 30 deg. F. may be easily maintained, which is well within the range required for retarding age-hardening for a period of at least 24 hours. The temperature must not be too cold, otherwise the handling of the rivets causes discomfort to the hands.

In his first article, published in the November issue, Captain Ritter discussed developments in design and performance of European bombers in the post-war period as compared with the machines available in the World War. In this, the second and last, he compares European fighting planes of 1918 and 1930. American types have been included in the graphs to indicate our own contemporary position

Post-war fighter progress

By Capt. Hans Ritter
Late of the German General Staff
(Air Force Section)

THE qualities in fighter aircraft to be considered include the amount of vision obtainable, the means of communication with the ground and other planes in the group in the air, the availability of appliances for maintaining physical and psychological efficiency at high altitudes, the maneuverability characteristics, and the efficacy of the armament.

Vision in single-seater fighters in the air is very limited, due probably less to style of construction than to the fact that there are too many functions to be carried out in a single-seater by one man. In the two-seater fighter, now gradually being developed, the situation in this respect is more favorable, while the multi-engined turret machine has additional advantages from the construction point of view.

Most fighter aircraft of late have been equipped with radio apparatus to maintain communication with command posts on the ground and with other aircraft in the air. Progress in this respect is best illustrated by exercises during the course of the 1930 Air Corps maneuvers in the United States, in which a pursuit squadron directed by radio carried out without difficulty a set of intricate drill movements. [The 1931 maneuvers furnished more evidence of the same sort.—Ed.] The machine of the squadron leader was equipped with apparatus for both sending and receiving, the machines of the five flight commanders for receiving only; the squadron leader was able to keep in continuous touch with the wing commander, who could be either on the ground or in the air. In aerial combat exercises, one wing equipped with radio was reported as pitted against another not so equipped. The result showed convincingly the superiority of the radio-equipped wing. In other exercises, the movements of three squadrons in the air were directed from a command post on the ground and from the wing commander's plane. Radio has also proved of great value in cooperation between bomber and fighter units.

Appliances for assuring the maintenance of physical and psychological efficiency of crews at high altitudes are entirely lacking in all fighter and bomber aircraft of today. In this respect technical science still has much to accomplish.

Maneuverability

Progress since 1918 in the development of maneuverability of fighter aircraft over their opponents—mainly determined, as mentioned in the November issue, by the ratio of weight to horsepower—is indicated in Fig. 1.

An even more serious lack of progress must be recorded in the matter of armament for fighters. A British expert, whose opinion coincides entirely with the author's, says in the *Royal Air Force Quarterly* of April, 1930: "We have in the past placed, and we still place, far too much value on speed and power of maneuver of small aircraft as an asset for fighting. We have been accustomed to expect large aircraft to be cumbrous, heavy to fly and relatively slow, but there is no technical difficulty in building large aircraft which will be extremely fast and which will have a power of maneuver equivalent to the smaller aircraft when allowance is made for length, height and span.

"Ruling out the question of surprise, which is a difficult thing to achieve in the air, superiority of speed and climb for an offensive fighter are useful only in that they allow the pilot to catch the enemy, deliver a quick attack, and turn away again—if he survives—to await the opportunity for another favorable attack. Taking all the factors into consideration, we must admit that the task of attacking a large aircraft with present-day single-seater fighters is rather a hopeless affair, but it becomes more hopeless if the larger aircraft is armed, as it may well be, with a proportion of guns firing shell at longer ranges."

Much development has still to be carried out in the science of aircraft construction and of designing armament suitable for use in the air. The effect of the individual projectile is the deciding factor for the attacking aircraft. Explosive ammunition of calibre of 0.75 to 1.5 with highly sensitive fuse, is required. As hitherto, the effective range of the weapon will probably remain the principal factor, and consideration must be given to the fact that in high atmospheric strata the initial velocity of the projectile sinks relatively slowly. To secure the most rapid decisive effect on the target, the multi-barrel gun might be considered. The greatest possible flatness of trajectory up to distances of 2,000 yards is desirable for the sake of accuracy. The muzzle velocity should, therefore, be about 3,200 ft. per sec. [This is somewhat above the usual figures for rifles and machine guns.—Ed.]

Armament

The mounting of weapons of offense must provide some degree of adjustability in order that aim at long ranges may be directed in a free and elastic manner. An adjustable mounting is necessary, also, so that a close formation of fighters may be capable of concentrating fire on one unit. Finally, such a mounting is necessitated by the

probable movements of the attacking force during the course of an engagement. Once the relative distance from an opponent has become such that fire can be opened with every prospect of success, it is to the interest of the attacker to maintain approximately this distance. He should be able to do this by virtue of his superior speed. Should this distance be continuously and rapidly decreased, the enemy obviously is given the opportunity of bringing the bulk of his close defense weapons into active operation, a situation the attacker would seek to avoid. Furthermore, the maintenance of accurate fire is only possible when distance from the target remains constant for an appreciable time. In a continuous reduction of distance, especially when this is happening rapidly, there is the risk of not being able to take proper advantage of gun-laying appliances. The attacker, therefore, should endeavor to carry on a running fight encircling the enemy or flying past him, but should not seek an engagement on converging courses.

These methods, however, can be adopted only when the offensive weapon can be aimed independently of the direction of flight, that is, when it is adjustable in the horizontal plane. Adjustability in a vertical plane should be provided also. Tilting of the weapon to achieve greater length of trajectory is one advantage to be gained. In a parallel engagement carried out at the same altitude as that of the adversary, the target offered is the smallest possible and usually consists only of the vertical section of the fuselage and the rudders. A much greater target is naturally represented by the supporting surfaces of the opposing machine, but they become exposed only to an attacker who, while maintaining his distance from the target, is able to place himself either above or below it. Should the attacking machine possess superior powers of climb, it will be able to take up this position at any time. A pilot often will choose this position for other reasons; for example, in order to come out of the sun. However, an attack from such a position is possible only when the attacker's weapon can be moved to the fullest extent in the vertical plane. Should this condition not be satisfied, the attack will only be possible by diving on the target, and then the advantage of being able to maintain a constant distance from the target will be lost. [Several British writers on air combat have urged that a gun adjustable in the vertical plane be provided, for reasons similar to those given by Captain Ritter.—Ed.]

Speeds of 1918 and 1930 in m.p.h.

1918	Ground level	10,000 ft.	5,000 ft.
Avro.....	120	110	103
Spad S20.....	147	137	130
Fokker DVII...	124	115	112
1930			
Amiot 140M....	150	149	146
Fokker DXVI...	179	180	183
Dewoitine D27..	173	170	160
Boeing F4B-1...	165	162	156
Boeing P12B....	171	162	157

In addition to the normal ring sight on the gun itself an automatic range corrector and appliance for determining lateral direction on the basis of movement of the target when courses are not quite parallel should be sought. It should take care, also, of the deviation of the projectile resulting from the machine's own speed and the weapon's angle of tilt to the direction of flight. Much development work has been done on range-correcting and windage-correcting sights, but they have not as yet passed into regular service use.

Fighters and bombers

General tendencies and the mental outlook in current development have been the important objects of our examination, rather than a yardstick measurement of details of progress. Comparing, from this point of view, the bomb loads of 1918 and 1930 which can be carried by bombers of approximately corresponding sizes, the most favorable results are shown in the light class of 1930 by the Aero A.42, with an increase of 300 per cent. [All these statements are based simply on European progress.—Ed.] In the medium-weight class there is the Leo 25 Bn-4 with an increase of 80 per cent; the Caproni 90 P.B. is the sole comparative 1930 machine in the heavy class, with an increase of 160 per cent. Thus a considerable increase in absolute bomb load in all classes may be recorded. However, comparisons between absolute increase of bomb load and the concurrent increase in engine power in the individual classes, and the power necessary in 1918 and in 1930 to convey one ton of bombs, speedily qualify apparent progress. Possibly more impressive and certainly more authoritative as an index of the military value of the aircraft, is the comparison of bomb loads over a certain range (600 miles) with the total weight of the aircraft. Here the progress achieved is considerably more modest than that in absolute military load.

If it be considered that the ability of a bomber to attain high altitudes (above fighters) is the principal quality necessary for overcoming enemy defensive measures both from the ground and in the air, then Fig. 3 in the November issue shows that only one type of light bomber, the Hawker Hart, presents an improvement in ceiling comparable in degree with the 50 per cent increase in effective range attained by anti-aircraft guns since 1918, and that this aircraft alone can exceed the effective ceiling of a typical single-seater fighter. All other light, medium, and heavy bombers show a negligible increase when compared with the increased range of anti-aircraft gun fire.

In regard to flying speeds of bombers and fighters of the years 1918 and 1930, the table in the November issue indicates an absolute increase of 15 per cent, or a relative one of 26.6 per cent, for heavy bombers. This is of no great importance, as the speed of a bomber is not as vital as its power to climb. Incidentally, if the Hawker Fury or the Fairey Firefly II were to be taken as the comparative machines for 1930, and not the Fokker DXVI, one would have to record a considerable step backwards in the ratio of

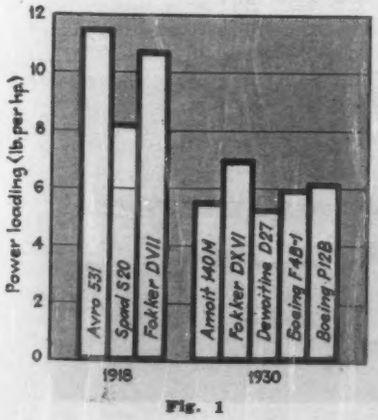


Fig. 1

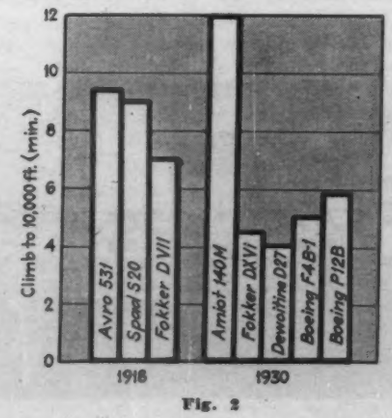


Fig. 2

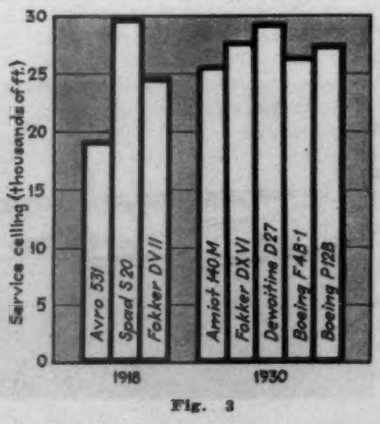


Fig. 3

speed of bombers to fighters as compared with 1918. The fighter has actually progressed more rapidly. [The table attached to Captain Ritter's prevous article would indicate a similar situation in the United States, but some very fast bombers are now undergoing test, and may reverse the trend.—Ed.]

The post-war development of bombers —the most important instruments in air operations—must, therefore, be described as completely unsatisfactory. Increase in bomb load in relation to the total flying weight is barely noticeable in the case of the light bombers. In the most important type, the heavy bomber (omitting the exceptional Caproni 90 P.B.) the increase is entirely insufficient. At any rate, it cannot be said to correspond with the increased measure of importance attached to the theory of air warfare since 1913. Considered from the standpoint of ability to climb (absolutely vital for the carrying out of successful bombing operations by day and, to a smaller extent, by night) no real progress has been achieved. This fact deserves particularly serious consideration. As long as it is not possible to carry air operations beyond the "coastal waters" of the "aerial sea" into the "open seas" of the upper atmospheric strata, battle conditions in the air will approximate those obtaining during the Great War, and no real advance in the art of air warfare will have been made. Technical science still has some extremely intensive development work to carry out and no longer be permitted to be satisfied with progress solely along the lines of increased engine power and a certain amount of aerodynamical "cleaning up" of the airplanes themselves, which have hardly been improved in their constructional principles since 1918.

The progress of fighter performance shown in Fig. 2 and 3 and in the table is equivalent to the decrease in weight in relation to horsepower shown in Fig. 1, but no more. However, in face of the slow development of bombing aircraft, we may be relatively content with the progress achieved in the development of the fighters. Should the development of the heavy bomber ever proceed along new lines, such as indicated herein, it will be necessary to seek new principles for fighters, in order to arrive at the "high seas" fighter aircraft of the "aerial ocean." An embryo of such a future development is represented by the multi-seater fighter previously mentioned, something on the lines of the French Amiot 140 M.

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Mono-spar construction

A full cantilever monoplane, saving about 40 per cent in wing weight

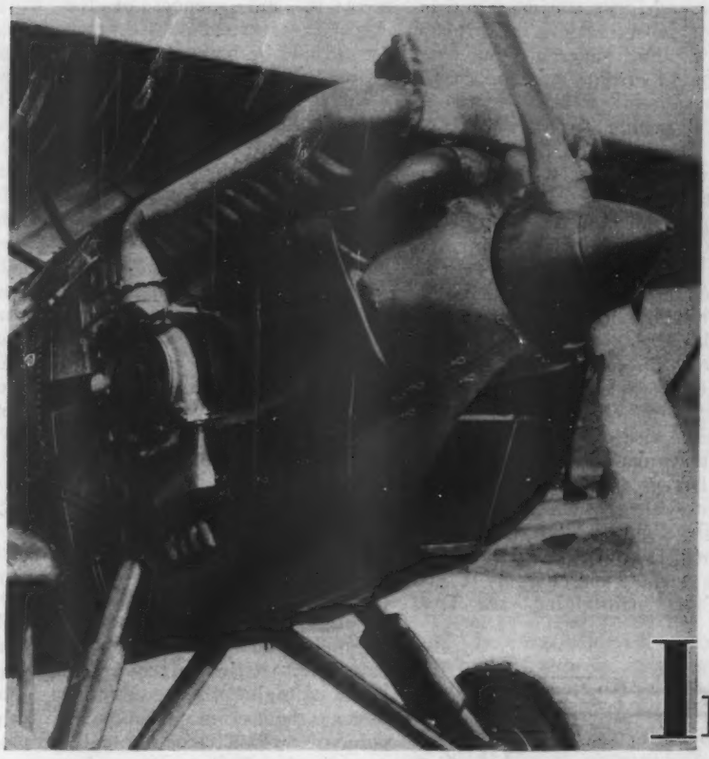
AN INTERESTING attempt to increase payload by decreasing structural weight has recently been reported by the Mono-Spar Company, Ltd., of London, England. A small machine was built for this concern by the Gloster Aircraft Company, Ltd., and has been successfully test flown. The company is now at work on an experimental wing to replace that of a standard three-engine Fokker monoplane for the British Air Ministry.

Tests have indicated that the mono-spar method of construction make it possible to obtain the aerodynamic advantages of a full cantilever monoplane with a saving in wing weight of approximately 40 per cent, and a total structural weight lighter than that of a conventional biplane of equal landing speed and power. The employment of a single spar placed at the point of maximum thickness of wing section affords the designer a wide range in the choice of airfoil, and the fact that all loads, including torsion, are carried by the single beam makes it possible to calculate all stresses and deflections fully and accurately. Tests have shown that the mono-spar wing has had no tendency to flutter under any conditions of flight. Fabric covering is used which makes for lightness in weight and economy in repair and maintenance.

The experimental machine is a three-place, low-wing cabin monoplane powered by two 50-hp. Salmson radial engines mounted in the leading edges of the wing.

The mono-spar wing is of the full cantilever type made up in three sections, the center section which carries the engines and landing gear, and two tip sections. The main structural member in all three sections is a deep duralumin beam made up of a plate web having triangular holes stamped out for lightness, leaving a series of lattice bars to act as braces between the top and bottom flanges. The flanges are formed of duralumin strips riveted to the web with reinforcing cover plates on the outside. To give stiffness to the structure, tubular king-post ribs are fastened to the spar at intervals, their ends interconnected by diagonal cross bracing tierods. This construction is used except in the tip which is braced by a false spar carrying an aileron which is placed at a decided angle with the main spar inward from the top. Two relatively heavy cantilever ribs add support also from the main wing spar. The entire wing is built of duralumin with the exception of certain steel fittings and plates. The leading edges are made of duralumin sheets, and the trailing edge of duralumin angle.

The mono-spar design has been applied to the fuselage in that the main structural member is a square box-girder, connecting the wings and the tail surfaces. The balance of the body structure is relatively light and is supported on the lattice work backbone. In this respect the airplane is similar to an automobile in that it has separate chassis and body structure.



A late turbo-supercharger installation

The S.A.E. discusses superchargers and controllable pitch propellers

Increasing power plant efficiency

TWO-THIRDS of the sessions of the Society of Automotive Engineers at Cleveland in September were given over to power plant problems, and they were exceptionally well attended. Particular interest was aroused by a turbo-supercharger paper, by A. L. Berger and Opie Chenoweth of Wright Field. Mr. Chenoweth presented in April a general discussion of supercharger theory and its effect on practical design. In the present contribution he went much further in application to a particular type, covering not only the theoretical limitations but the practical problems and the history of turbo-compressor development for supercharging purposes.

When supercharging first became a subject of practical consideration, about 1916, direct gear drives appeared quite hopeless, and the exhaust turbine was adopted as the only possible device. There, too, mechanical limitations, and especially the inability of materials to stand up to the high temperatures existing in the turbine casing, proved so serious that it was a couple of years before any success was gained.

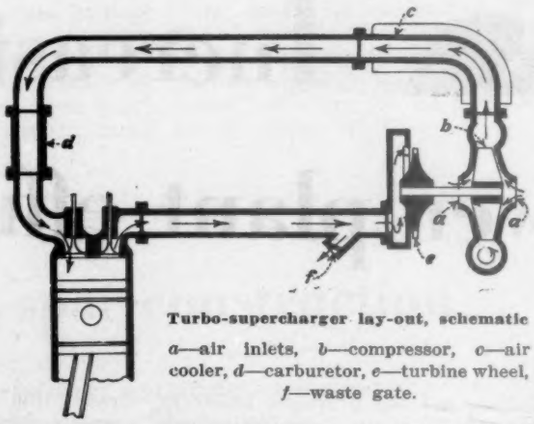
Vapor lock was another serious trouble in the early supercharger installation, and was overcome finally by putting the air pumps down in the landing gear with remote control, so that the pump would be below the tank at all times and fuel would never have to be lifted by suctiton. The pump on the landing gear delivers the fuel to a quadruplex syphon pump which feeds it directly to the carbureter, the sylphon pump being equipped with an automatic by-pass regulator so that it will maintain a constant excess of fuel pressure above the supercharger pressure in the air intake pipe at all times. The turbo-superchargers so far built have practically all been of the pressure type, where the carbureter is between the supercharger and the engine, and the authors of the paper believe this to be best, although the suction carbureter with the supercharging applied to the final mixture is commonly used where the drive is geared instead of turbine.

Engine cooling is of course a serious problem with any supercharging installation, and it is further complicated by the necessity of providing additional radiator surface or the equivalent for cooling the air after it leaves the supercharger in order to get satisfactory volumetric efficiency. To overcome the steady drop of boiling-point with increasing altitude, supercharged machines have been fitted with pressure radiators, with safety valves set to blow off at about 5 lb. per sq.in. Such a radiator must also have an automatic intake valve to guard against pressure in the radiator dropping below atmospheric and causing collapse of the radiator tubes in case of an engine stoppage in high altitudes and the resultant sudden cooling of the water. Heating of the air due to compression, which sometimes raises the temperature in the carbureter as high as 240 deg. F. is taken care of by honeycomb intercoolers, the best type weighing some 26 lb. and having a total cooling surface of 36 sq.ft. for a 400-hp. engine. In a typical flight of a supercharged airplane with a good intercooler the temperature at the carbureter never went above 80 deg. or below 60 during a climb to 30,000 ft., although the temperature at discharge from the air compressor rose to about 180.

The purely mechanical problems already referred to have been much simplified, at least so far as the exhaust manifold is concerned, by the introduction of the side-type supercharger in

place of the old arrangement with the turbine directly on the nose. Efficiency has been increased and cooling in the turbine itself improved in recent designs by replacing the old horse-shoe type of nozzle-box, in which the gases went both ways around the turbine casing from the exhaust manifold and half the gas then had to reverse its direction in order to enter the turbine bucket, by a continuous flow type with the gas all moving in the same direction and completely surrounding the turbine rotor. The buckets themselves give less trouble than formerly because of improved technique in manufacture, and especially because of improved material, the so-called iron-base alloy, a chrome-tungsten-nickel steel, having shown great improvement over all its predecessors for this service.

The problem of a propeller for a supercharged installation is as yet incompletely solved. The ideal propeller would of course increase its diameter and slightly increase its pitch with increasing altitude. Variable diameter being outside the realm of practical possibility, the designer has to limit himself to variable pitch and variable r.p.m. The future of the supercharged airplane is peculiarly dependent upon the improvement of controllable-pitch propellers and their availability for general service. Variation of r.p.m. was accomplished in one trial installation, some seven years ago, by providing a gear shift in the engine, using a propeller of large diameter and starting it from the ground in the geared-down setting, shifting into a higher gear or into direct drive after reaching a considerable altitude. That is of course strictly right for only two altitudes, but it is a great improvement on a perfectly rigid power-plant installation.



Turbo-supercharger lay-out, schematic

a—air inlets, *b*—compressor, *c*—air cooler, *d*—carburetor, *e*—turbine wheel, *f*—waste gate.

Supercharged performance

The authors of the paper indicated that the bugaboo of low acceleration of the supercharger, which has been considered a serious drawback of the turbine type for military service, has been largely overcome in the latest side-type installations. The supercharger is now fitted with an automatic regulator to maintain a constant absolute pressure in the in-take manifold at all altitudes, and present turbo-superchargers will pick up to full sea-level power at an altitude of 10,000 ft. in about three seconds after the supercharger is cut in from the unsupercharged condition.

The paper closed with some observations on supercharger efficiency and on the effect of supercharging on airplane performance. Full supercharging by a supercharger of turbine type for a typical modern pursuit airplane increased the service ceiling from 23,000 to 32,000 ft., decreased the time to climb 20,000 ft. from 24 min. to 13, and increased the level speed at 20,000 ft. from 135 m.p.h. to 181, the speed of the unsupercharged machine at sea level being only 162 m.p.h. All this was with a fixed-pitch propeller, holding the engine to far below its normal r.p.m. at low altitudes.

The effect of ground boosting by supercharger is to increase the brake mean effective pressure about 4 lb. per sq.in. for each rise of one inch of mercury in intake manifold pressure.

Messrs. Berger and Chenoweth closed their paper with the observation that from the development so far, the following conclusions are drawn:

(1) The turbo supercharger is satisfactory for maintaining sea-level pressure at altitude on service-type equipment.

(2) Tests indicate that the turbo supercharger can be used for extensive ground boosting if the engines, fuel, spark-plugs, and carbureters will withstand the service. In the light of present knowledge, the indications are that for a given boost, the turbo-supercharger application requires better fuels and valves than the geared-centrifugal application because of the higher-temperature residual exhaust gases.

(3) The supercharger is responsible to a large degree for the present high state of development of the internal-combustion engines for aircraft use, as well as all related equipment.

The discussion of the paper was comparatively brief except for a contribution by Dr. S. A. Moss of the General Electric Company, who has been a major factor in supercharger development since its beginning. Dr. Moss paid special tribute to the late E. T. Jones, chief engineer at McCook Field and subsequently at the Wright Aeronautical Corporation, for his encouragement to and support of the work. Apropos of troubles with material in the turbine he pointed out that the centrifugal force on a bucket in the turbine rotor at full rotor speed is about 70,000 times its weight, or about 700 lb. He was optimistic for the future of the turbo-supercharger, not only in high-performance military work but also in commercial service, where he thought it might replace the geared type. Summarizing the sad state of the engine designer, Philip B. Taylor, chief engineer of the Wright company and chairman of the session, remarked in closing the meeting that that unhappy individual was never through, for someone was always devising a new expedient such as the turbo-supercharger for breaking up the power plant.

Radiatorless liquid cooling

John H. Geisse, vice-president of engineering of the Comet Engine Corporation, spoke on the use of sealed cooling systems without radiators, cooling being secured entirely by the circulation of ethylene glycol or some other liquid of high boiling point through the jackets themselves. The parts of the cyinders which are normally coolest are thus enabled to carry heat away from those that have the maximum heat absorption from the combustion space.

An engine was built by the Comet company, on a Navy contract, to test the idea. An essential object of the new form being to reduce the air resistance as compared with that of a radial engine, a six-cylinder-in-line arrangement was used. The cylinders were cast in block, with parallel enclosing walls carrying the cooling fins, which ultimately gave the heat up to the air. The cooling liquid circulated in the space between each pair of cylinders and in a continuous passage over the cylinder head. Channels were also provided along the sides of the cylinders near the top (the engine being run inverted) to admit of continuous thermo-syphon circulation. A pressure relief valve was provided in the cooling system to prevent building up dangerous pressure in the liquid.

The original plan had been to space the fins one inch apart on the cylinder block, as it was feared that a narrower spacing between fins running the whole length of the engine would result in creating dead spaces of very little air flow. The results of experiments by Prof. C. F. Taylor, however, came along just in time to show that the fear was unwarranted, and the fin spacing was thereupon reduced to one-half inch. The total cooling surface on the cylinder block was 2,835 sq.in. for an engine developing 138 hp., approximately 1,400 sq.ft. per hp.

The design was of course a preliminary one, in which there was no attempt to reach the ultimate possible efficiency and the ultimate in weight re-

ductions. The piston displacement was 461 cu.in., and the power output of 138 hp. was attained at 2,360 r.p.m., giving a brake mean effective pressure of 100 lb. per sq.in. The engine weight was 345 lb., or exactly 2.5 lb. per hp., including 14 lb. of diethylene glycol.

Cylinder temperatures were very satisfactory in their regularity, the hottest point found having a temperature of 405 deg. F., while the temperatures in the barrels remote from the head ranged around 325 deg. The liquid itself circulated at a temperature range of from 380 to 390 deg. F. All this was with an air temperature of 88 deg. and an air velocity of 90 m.p.h.

Mr. Geisse was very optimistic about the future of the type, claiming for it "the advantages of both air cooling and the familiar form of liquid cooling and the disadvantages of neither." He particularly criticised the radial air-cooled engine on the ground of necessary roughness of operation, which he believed would make it permanently unsatisfactory for transport service or for wide spread private ownership. He took a very substantial reduction in head resistance of the new in-line engine, as compared with the radial form, as almost axiomatic, nine more or less independent cylinders being replaced by one body of large fineness ratio and good streamline form. His confidence in the future of sealed liquid cooling extended not only to small gasoline engines but especially to diesels, which he believed would in future necessarily be of in-line or of V-form and operating on a two-stroke cycle.

Although all those contributing to the discussion paid high tribute to the interest of the work done by Mr. Geisse, it was to be expected that some of them would firmly decline to accept his claims as a whole. A discussion submited by Mr. Willgoos, chief engineer of the Pratt & Whitney Company, pointed out that the engine was still in an early stage of its development, called attention to the low mean effective pressure, and to the fact that it was easy to secure low cylinder temperature in any type of engine if the cylinders were of sufficiently small bore. Showing what could be done with direct air-cooling, Mr. Willgoos remarked that an air-cooled cylinder of 6¼-in. bore had recently been run 100 hours at full throttle, and at 161-lb. brake m.e.p., with a maximum cylinder temperature of 468 deg. F., only 60 deg. above that for the Geisse engine on test. He believed that brake mean effective pressures in that region would be essential in future designs, particularly for military engines.

Further, Mr. Willgoos denied that radial engines were necessarily rough. He believed that when there was excessive vibration it was the result of bad installation rather than of faults in the engines themselves. And finally, he argued that a new possibility of weakness and of lowered reliability existed in the possible fracture of the jacket and loss of the cooling liquid in the sealed type of engine.

Mr. Geisse replied that the bore of his engine was only ¼ in. less than that of the Wright J-5, that the roughness of the radial engine was fundamental in its performance characteristics and might be disguised by a flexible mounting but could never be eliminated, that many installations were in fact unbearably rough, and that in practice leakage of water jackets due to the breakage of cylinder castings was unheard of. Where leakage troubles had been experienced in water-cooled engines they had been with welded cylinders, like those of the Liberty.

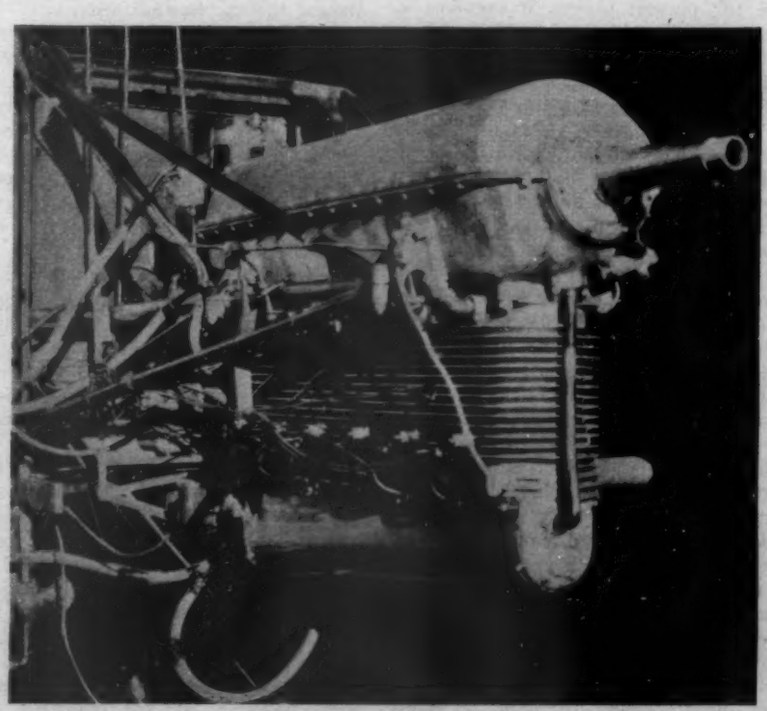
Propeller problems

With the variable-pitch propeller becoming a commercially available accessory, propeller design is entering a wholly new phase where all its phases must be reconsidered. Papers by Frank W. Caldwell, chief engineer of the Hamilton Standard Propeller Corporation, and by D. A. Dickey and Lieut. O. R. Cook of Wright Field, bore on the changing state of affairs. Mr. Caldwell attributed to metal propellers, with their thin blade sections, a rise in permissible tip speed from about 700 ft. per sec. to about 950 without serious loss of efficiency.

He lamented the failure of mathematical research to provide any quantitative means of analyzing stresses due to propeller vibrations. Torsional flutter can be guarded against only by the whirling test at Wright Field. One type of vibration capable of making a great deal of trouble in flight does not ordinarily appear even in the whirling test. It is a flexure of the blade in the plane of rotation of the propeller, attaining its greatest magniture when nautral periods of vibration synchronize with the forced periods resulting from the variation of engine torque and the impulses of the separate cylinders. This, said Mr. Caldwell, has been likely to cause failures of the hub and breakages of the blade at the point of attachment to the hub.

The safe life of propellers has never been definitely determined, depending as it does very largely on the conditions under which they are run. Mr. Caldwell reported some cases of more than 2,500 hours of service without apparent deterioration. In other cases inspection had uncovered progressive failures after 1,200 to 1,500 hours, failures which would have led rapidly on to real trouble if neglected.

The development of new test methods becomes all the more important when, as at present, many propellers of novel types are seeking introduction. Magnesium alloy is on trial and has the advantages of exceedingly light weight about one-third less than the familiar aluminum alloy) and of high fatigue limits. Mr. Caldwell, however, indicated that the material was very seriously affected by concentration of stress, that great care in design would accordingly be necessary, and that magnesium was as yet definitely experimental. The hollow steel blade is progressing from experimental into service status, and Mr. Caldwell considered it particularly promising in the largest sizes, where



Mr. Geisse's air-tight engine

the tubular steel blade would be much lighter than a solid duralumin one.

Controllable pitch

The Caldwell paper contained some general comment on controllable pitch propellers, but they were treated in much greater detail by Mr. Dickey and Lieutenant Cook, who recapitulated the history of the development since the Army began to work on the development of Seth Hart's design in 1918. At the present time there are about a dozen different types, with hydraulic, mechanical, and electrical control. Some are infinitely variable in position, some have two definite pitch settings, others three. Some are operated by manual effort, others by engine power. The Air Corps propeller has manual control through a mechanical transmission, and is working out satisfactorily so far, although the flying time has not exceeded 200 hours on any single propeller, and it is too early to predict suitability for general service. The hydraulic type is represented by the Hamilton Standard two-position propeller, and that developed by Hele-Shaw in England. Electrical control is embodied in the Curtiss-Wright development of the Turnbull design and in the work of Ratier and LaVasseur in France. Electrical control is perhaps most readily adaptable to infinite variation of blade angle.

Automatic propellers, those to which the pilot need give no thought but which automatically set themselves for the correct pitch angle corresponding to the conditions of flight, are as yet largely in the theoretical stage. The Materiel Division of the Air Corps has considered that, although automatic variation is obviously of great importance for pursuit planes, it involves so many special problems that it should not be taken up until the difficulties of the manually controllable type have been fully solved. It was mentioned during the discussion, however, that the Bendix Company has an automatic propeller under development and that it has reached the point of flight test.

In the course of discussion of the two papers Mr. Geisse pointed out that the provision of controllable pitch was becoming more and more important as the speed range of airplanes, and consequently the gap between maximum speed and climbing speed, increased, and also that it had a great effect on the ability of multiple-engined planes to fly with one engine off. The vital importance of ability to vary the pitch with a supercharged engine has already been mentioned in connection with the Chenoweth paper. In response to a question about the actual practical effects of providing controllable pitch, Mr. Caldwell suggested that for typical cabin ships the rate of climb would probably be improved about one-third and the take-off run reduced about 20 per cent. Only a very limited body of data on these points is as yet available. Mr. Caldwell went on to say that Hamilton Standard had now put about twelve of its controllable pitch propellers into service, on power ratings up to 600 hp., and that one had already had 380 hours of flying. E. E. Wilson, president of the Sikorsky and Vought companies, questioned the desirability of a three-setting type of propeller. He considered it quite sufficient to provide settings for take-off and cruising speeds.

Solid-injection engines

A long paper on direct fuel injection with spark ignition in a standard type of engine was presented by E. S. Taylor, younger brother of Prof. C. F. Taylor and of Philip B. Taylor of the Wright Company, and George L. Williams of the Massachusetts Institute of Technology. It supplemented a similar discussion by the same authors offered at the annual meeting of the S.A.E. in January, the previous paper having dealt particularly with four-cycle engines and the present one with the possible application of direct fuel injection to two-cycle power plants. Experiments were made with gasoline, fuel oil, and a hydrogenated fuel having somewhat the appearance and specific gravity of gasoline, but with a distillation curve more nearly resembling that of fuel oil.

The paper contained many curves and much discussion hardly capable of abstract. In general it was found that extreme turbulence in the cylinder was necessary in order to diffuse the fuel through the air and to give steady operation, and it was secured by shrouding one side of the intake valve so that all the air would enter the cylinder at the other side and have to circulate around the combustion space.

One advantage of direct fuel injection is that the engine performance is much less variable with changing mixture ratio than when a carburetor is used. There is no such sharp rise in fuel consumption and drop in power with too lean a mixture as is common experience with conventional engines. The authors' general summary of their conclusions included:

(1) With injection timings suitable for application to two-cycle engines, that is, injection after the closing of the inlet valve, better power and better fuel economy may be obtained than is possible with either early injection into the inlet pipe or with a conventional carbureter.

(2) Gasoline or hydrogenated fuels of low volatility may be used in this application with equally good performance. The possibility of using hydrogenated fuels of low volatility but high anti-knock value is especially promising.

(3) Ordinary low grade diesel fuels of low volatility may be used with injection for two-cycle engines, but with performance inferior to that obtained with gasoline or hydrogenated fuel.

Turning from the fundamentals of engine operation to the problems of light-weight construction, G. D. Welty of the Aluminum Company of America treated magnesium alloys in aircraft engines. Magnesium castings have been largely employed in that service, magnesium forgings to a very limited extent. Mr. Welty reported rapid progress in recent months in the development of forging alloys. Alloy 61S, a third lighter than the standard high-strength aluminum alloys, has about a third less ultimate strength and elasticity but quite as high a fatigue limit as the best of the aluminum-base materials. Magnesium forgings cannot simply be substituted for aluminum ones without change of design, and Mr. Welty was not encouraging on the prospects for magnesium connecting rods. The principal use of the material is in the cast form, where it shows an ultimate strength almost equal to aluminum alloy No. 195 and a fatigue limit almost 50 per cent higher. The volume of magnesium castings used in the aircraft industry has increased steadily through the years of depression, from 29,000 lb. in 1928 to 61,000 in 1929, and an estimated total of 65,000 lb. this year. Roughly speaking, the weight of castings per engine built in the United States has gone from 7 lb. in 1929 to 20 lb. in 1931.

Corrosion has proved a much less serious problem than was feared when the material first went into service. Where there is no continuous exposure to salt air, magnesium castings have shown a high degree of corrosion resistance with no loss of mechanical properties. There are, said Mr. Welty, no known instances of inter-crystalline corrosion, the dreaded enemy of duralumin. Corrosion in magnesium can always be determined by visual inspection of the surface. Mr. Welty did not recommend the use of magnesium where it would have to be immersed in salt water, and wherever conditions were particularly severe, as on seaplanes, he advised protection by varnish, lacquer, or bitumastic paints. Corrosion resistance is being steadily improved, especially in new alloys now under test.

It was complained in discussion that magnesium always proved a failure near wooden members. Mr. Welty attributed that to chemicals in the wood. A somewhat corresponding problem had arisen in engines, where corrosion had been at its worst under gaskets containing chlorides and other corrosive salts. Some fears were expressed for the need of extreme care in heat treatment, but Mr. Welty declared it no more troublesome than with the high-strength aluminum alloys. Several speakers, including Arthur Nutt of the Curtiss-Wright Company, paid warm tribute to the amazing advances in the arts of casting and forging magnesium, and to the great improvement of the material, during the last five years.

The Loth system of energized cables for fog landing guidance

Landing blind

By Frederic Celler
Technical Director,
American Loth Corporation

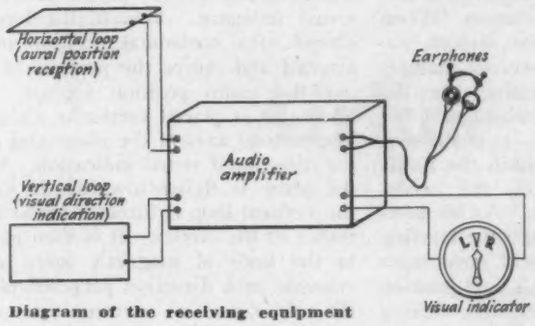


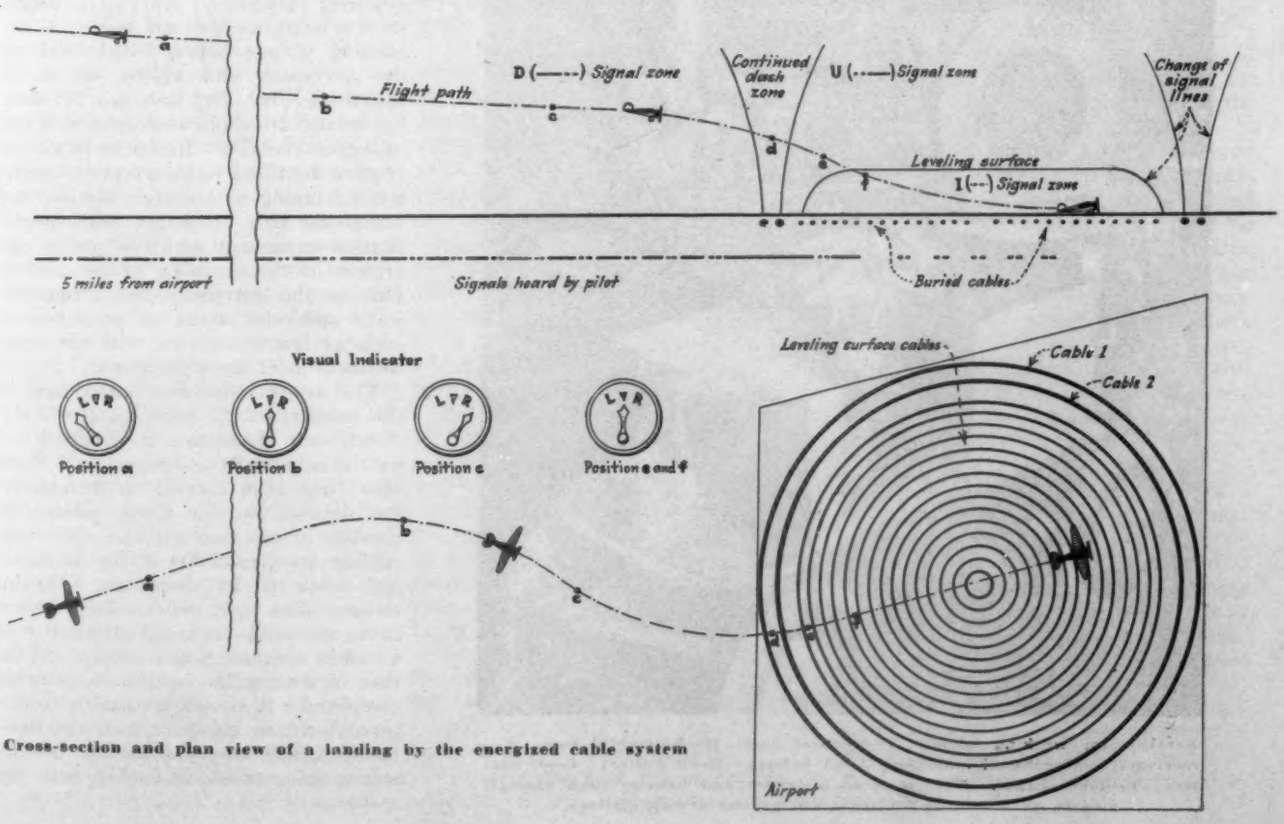
Diagram of the receiving equipment

FOG FLYING, or, more accurately, reduced visibility flying, can be divided into two operations: Cross-country flying and blind landing. The former type of flying has greatly advanced since the time when pilots avoided flying through clouds. To-day all types of pilots from the casual flyer who follows the railroad on a hazy day through the mail and transport pilots who make use of the radio beacon, homing loop, etc., to the round-the-world navigator who uses complicated kinds of navigation, are flying under conditions of reduced visibility. While much still remains to be done for cross-country blind flying in the improvement of both outside aids and cockpit instruments, it can be said that this type of flying is well advanced and is done regularly.

There remains the last step—the providing of a means for landing in times of reduced or no visibility, as cross-country blind flying is useless if it is impossible to land when the destination is reached.

For the past fifteen years in France William Loth and his associates have been at work upon both maritime and aeronautical aids to navigation. In the course of their work they undertook to investigate the possibilities of fog landing and devised several methods and aids which might make such landings possible. There resulted from these experiments a simple and positive system using energized cables which was first made public in 1930. A small installation was made at the Loth laboratories, and is being followed by a complete military installation, supported by the French Air Ministry, on a government airport. It is this basic system which is now being presented in America, and which is undergoing investigation and test by the Army Air Corps at Wright Field.

The Landing Cable System presents to the pilot coming from a cross-country



Cross-section and plan view of a landing by the energized cable system

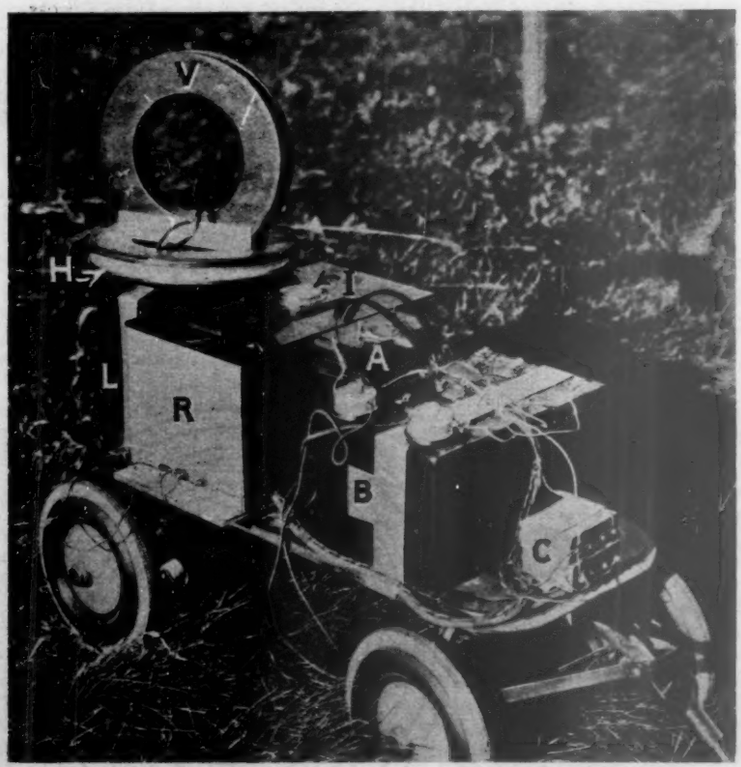
flight a target approximately ten miles in diameter. Once he is within this region, he receives continually the signal telling him that he is within the region of the airport, but outside of its limits. At the same time a visual indicator, a pointer on the instrument board, tells him whether or not he is headed towards the airport and guides him towards that center from any direction of approach. He proceeds to fly towards the center, and upon reaching the edge of the airport there occurs first a continued dash, indicating that he is over the boundary, and then a change of signal showing him that he is within the limits of the airport and that he may nose down for the landing. On reaching anywhere within the limits of the airport, a predetermined altitude (perhaps 20 ft.) there occurs a second change of signal which shows the pilot that he is at that predetermined distance from the ground and that it is time to level off slowly for the contact.

A graphic illustration

The figures on page 699 show the approach of an airplane towards an airport equipped with a cable landing system, and illustrate the signals and indications received by the pilot. In position *a* he has just reached the edge of the target and begins to hear the code letter D (— . .). At the same time his visual indicator allows him to head straight towards the center of the airport, as shown in the lower part of the drawing. If he should deviate in direction, as at *c*, his indicator will immediately register this deviation. When he reaches the limit of the airport, position *d*, the signal he receives changes to a steady dash indicating that he should nose down, then immediately becomes the letter U (. . —), position *e*, telling him that he is within the limits of the airport and above the predetermined leveling surface. As he noses down, he will pass through the leveling surface and the signal will once more change to the letter I (. .), position *f*, warning him of the immediate vicinity of the surface of the airport so that he may pull back slowly on the stick.

All this is accomplished with a series of cables laid in concentric circles under the surface of the airport. Energized by means of an alternating current at an audio frequency (between 500 and 3,000 cycles per second), the outermost cables produce the boundary signals as well as the directional indication. The current generated by a 15-kw. alternator passes through balancing units and keying devices and is then fed through the cables, the variations of current and the keying giving the changes of signals described above. Reception is achieved by means of two loops mounted on the aircraft, which are energized by the magnetic field created about the cables when current passes through them. The current thus set up in the loops is amplified by means of an ordinary audio amplifier and transmitted to the ear phones and to the visual indicator. One of the loops is placed in a horizontal position in the aircraft and serves the purpose of giving the audio position signals. The other one is placed vertically along the longitudinal axis of the plane and gives the directional visual indication. When the plane is flying towards the center the vertical loop is directed towards the center of the circles. It is then parallel to the lines of magnetic force which emanate in a direction perpendicular to the cables, and no current is set up in the loop. When it is not directed towards the center some of the magnetic lines of force will cut its surface and a current in the loop will result.

The pilot always knows, once he has come within the region of reception, whether he is inside or outside of the airport. He has a definite indication by a change of signal to determine the time to go into his glide, and he has a positive check on his close approach to the ground by another change of signal. Also, he is able to fly straight towards the center of the airport from any direction, and is directed towards a point without being obliged to follow a predetermined straight line.



Receiver for working model. V—vertical loop; H—horizontal loop; R—receiver; I—directional indicator; A—A battery; B—B battery; C—C battery; L—loudspeaker. This receiver is larger and heavier than aircraft models, as it is used for tests and ground demonstrations.

Material advantages

Materially, the system also presents certain advantages. The fact that simple and well known electrical equipment is used is of great advantage in attaining reliability. All that is necessary to start the ground system is the pushing of one button which will set the alternator and keying device in operation. In fact, this can be done by means of a photo-electric cell reacting to visibility. Reception does not require the usual radio reception operation of tuning to a certain station, but makes use only of simple audio amplification equipment which is put in operation by the throwing of one switch. Due to the extremely low frequency, static and other types of interferences, such as ignition noises, will not come through under any conditions.

The system was first introduced in this country in the early part of 1931. A full scale installation at Wright Fie'd has been partially completed, and flight tests have been carried on throughout the summer by Air Corps pilots. It consists of the two outside cables, enclosing an area 3,000 ft. in diameter, and a low power alternator. The interior cables for the leveling system have not yet been installed because of a lack of adequate power supply. At the time of writing the installation is being completed. A complete working miniature 70 ft. in diameter has also been installed, and has been used to demonstrate the results obtainable with the system.

The Philadelphia S.A.E. hears Luther Harris on

Airline maintenance

LUTHER HARRIS, superintendent of maintenance of the Ludington Airlines, Inc., whose tri-engined Stinson transports have achieved a notable record for safety and regularity between New York and Washington during the past year, was the principal speaker at a dinner given by the Philadelphia Section of the Society of Automotive Engineers on Wednesday evening, Oct. 14. Long association with the problem of keeping airplanes fit to fly has put Mr. Harris in a position where he can comment with authority on the relationship between airplane design, and airplane maintenance.

It has often been said that the sole commodity which air transport has to offer to the public is speed. From the passenger's point of view speed concerns merely elapsed time from the beginning to the end of his journey. Behind the scenes, however, are two other concepts of speed, which, unfortunately, are often diametrically opposed. The designer fingers his slide-rule lovingly and puts "pants," "spats," and what-not on his airplane to squeeze the last mile per hour possible from his power available. To the maintenance man, on the other hand, who is forever pushed to the limit of his ability by the demands of his traffic department, differences in top speed of 3 or 4 m.p.h. are of much less consequence than the fact that a simple fifteen-minute brake servicing job may then require two hours to complete. After a few such experiences it is only natural that he is inclined to view many of the designer's pet ideas with the cold eye of suspicion. More than one set of wheel fairings are now collecting dust in hangar lofts simply because maintenance departments cannot afford to tear them down and rebuild them every time brakes or wheel bearings must be serviced. If wheel cowling or similar gadgets must be used to permit an airplane to meet its scheduled speed, then it is time to think about retractable landing gears.

To the maintenance man, speed on the ground is more essential than speed in the air, and he is convinced that the planes of the future must not be designed primarily for performance, but must be designed for low-cost of maintenance. Accessibility, serviceability and interchangeability are the important things. Designers and maintenance men must in some way coordinate their efforts to produce machines that will not merely fly, but which may be flown at a profit, without the necessity of altering many of the details after delivery.

Not only must more attention be paid to questions of maintenance in the design of the airplane as a whole, but also persistent study must be made of all accessories and materials which are used for repair or replacement. Such items as tires, spark plugs, instruments, etc. must be given continual attention to insure that maximum life consistent with safety is being obtained. These items, while small in themselves, loom large in the total maintenance cost, and the savings which may be effected by careful analysis may easily make the difference between over-all profit or loss.

The importance of the several items which enter into the maintenance cost on an airline was illustrated by a breakdown of the actual cost of operation of the Ludington line on the basis of 1,600,000 airplane-miles. A total operating cost came to $0.375 per airplane-mile, of which about $0.15 a mile went toward general overhead, including the requirements of operations, traffic, publicity, accounting, and general management,—leaving approximately $0.22 a mile (or about 60 per cent of the total) to cover the maintenance costs of the airplanes. Further analysis yielded the breakdown shown above.

Maintenance costs—Ludington	Cost in dollars per airplane-mile
Routine airplane servicing between flights.	0.0202
Routine engine servicing between flights..	0.0035
Cleaning inside and outside of planes....	0.0040
Engine removal, overhaul, and installation	0.0116
Major repairs to airplanes.....	0.0111
Clerical and engineering salaries.....	0.0090
Total labor	**0.0594**
Gasoline	0.0407
Oil	0.0045
Engine parts (three engines).....	0.0100
Airplane parts (except those given below).	0.0150
Propellers and instruments	0.0022
Tires	0.0023
Spark plugs	0.0027
Total parts and supplies.....	**0.0774**
Depreciation—airplane, engine, accessories.	**0.0700**
General overhead—hangar rent, etc......	**0.0162**
Total maintenance	**0.2230**

The constant care which has been exercised in the control of maintenance costs is one of the principal reasons for the absence of red ink on the annual report. There is little doubt that the revising of the flying equipment with a view toward expediting maintenance operations to the limit has been one of the most important contributing factors. With the changes that have been made, and with the careful training of the line crews to a point of maximum efficiency, the time for inspecting and servicing an airplane between runs has been reduced from a matter of hours to some eight minutes. After all, the speed of airline operation is dependent not on the actual speed of the machine in the air but on the speed at which the ground operations can be conducted. The problem for the designer today is not so much concerned with air speed, as it is with "ground" speed, for it must be cheaper to design speed and convenience for maintenance into an airplane than it is to build it in after the airplane has been delivered to the operator.

The second of two articles. Mr. Gassner concludes his investigation of manufacturing costs and performance of a group of passenger carrying airplanes

Transport planes for profit

By A. A Gassner

IN a previous article (AVIATION, November, 1931) the weight and cost problems of single-engined planes, equipped with 575-hp. engines, have been investigated, and relations between wing and power loading combinations and performance of the plane have been established by using simplified performance formulas. The data so obtained represent of course only averages and the specific design of a plane will result in weights, costs and performance figures which differ more or less from these averages. The data obtained enable us to analyze groups of planes with varying wing and power loadings to establish relations between these factors and performance and transportation cost per passenger-mile. The performance formulas were treated in AVIATION, January, 1931, page 55, and March, 1931, page 187.

We have given in Fig. 1 (AVIATION, November, page 637) the limitations for wing and power loading combinations. If we choose for instance a power loading of 10 lb., the gross weight for the plane with a 575-hp. engine would be 5,750 lb. With a wing loading of 16 lb. per sqft., the wing area would be 360 sq.ft. The weight of the empty plane would be 3,610 lb. according to Fig. 3 (AVIATION, November, page 639) and the total useful load would be 2,140 lb. The airplane with same power loading of 10 lb. per hp., but with a wing loading of 14 lb. per sq.ft. would have a wing area of 412 sq.ft., a weight empty of 3,800 lb., and a useful load of 1,950 lb. The reduction of landing speed from 64 m.p.h. for the airplane with 16 lb. per sq.ft. wing loading to 60 m.p.h. for the plane with 14 lb. per sq.ft. wing loading, that is by 6.25 per cent brought a reduction of useful load by 6.25 per cent. The maximum speed of the two is respectively 176 m.p.h. and 168 m.p.h., the machine with lower wing loading is therefore slower by 4.55 per cent. For the cruising speed we obtain respectively 146 m.p.h. and 139 m.p.h., the slower machine must carry more fuel load for same range, which brings a further reduction of payload. This short example shows that it is most essential to investigate all these interconnected problems very systematically and we have used data contained in Figs. 1 and 3 to make up Table VI.

Performance calculations have been made by using the formulas contained in the previous article. Cruising speed is assumed to be equivalent to 83 per cent of maximum speed and to be obtained at 85 per cent of the r.p.m. of normal rated maximum horsepower. Range for all planes is taken at 500 miles at cruising speed, and fuel consumption at cruising r.p.m., that is at 1,660 r.p.m., is taken at 0.3 lb. per hp.-hr. for 575 hp., equivalent to 172.5 lb. or approximately 29 gal. per hour. Weight of pilot—170 lb., weight of lubricating oil—90 lb., and weight of radio and other equipment—140 lb., or a total of 400 lb. are considered as part of the dead weight, same as the weight of the empty plane. Payload is therefore the difference between gross weight and weight of fuel, pilot, oil, and equipment.

Useful load (W_{UL}) in this study is weight of payload and fuel load. The transportation factor $(W_{UL}/\text{hp.}) \times V_{cruis}$, and the method of calculating operating cost per hp.-hr. are explained in another article (AVIATION, October, 1931). The transportation cost per passenger-mile is calculated by the formula given in above article, which reads

$$C_{PM} = C_{hp.} \times \frac{200}{\left(\frac{W_{UL}}{hp.} \times V\right) - 0.3R}$$

Sales prices of planes with various wing area are found in Fig. 3.

Values for transportation cost per 200 lb.-miles as calculated on Table VI, are plotted on Fig. 4 for various wing and power loadings for a cruising range of 500 miles. In the beginning of this study we have stipulated that landing speed shall not exceed 65 m.p.h. and that transportation cost per 200 lb.-miles shall not be higher than 4 cents. All wing and power loading combinations shown in Fig. 4 below the line of transportation cost of 4 cents and above curve representing wing loading of 16.5 lb. per sq.ft. fulfill these requirements.

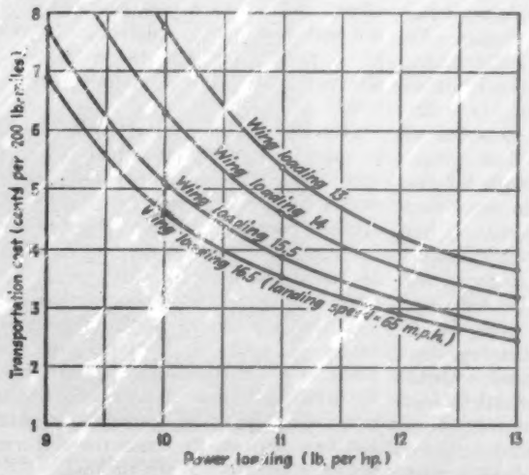


Fig. 4: Transportation cost per passenger-mile of a single-engined plane (575-hp. engine). 500-mile range.

Fig. 1 has been completed by including curves of values of transportation cost. This is shown in Fig. 5.

Fig. 5 gives the answer to the problem. Values of wing and power loadings in the area formed by the curves con-

necting the points *A, B, C* and *D* are possible and in accord with the basic requirements. The plane with characteristics as per point *A*, that is with a wing loading of 16.5 lb. per sq.ft. and with a power loading of 10.5 lb. per hp., is the fastest possible with a transportation cost of 4 cents per passenger-mile. At the same time it has also the highest rate of climb — 980 ft. per min. Its maximum speed would be 174 m.p.h. The airplane characterized by the values of point *B* has the lowest transportation cost—2.64 cents per passenger-mile. Its wing loading is 16.5 lb. per sq.ft. and its power loading 12.62 lb. per hp. The rate of climb for this plane is 600 ft. per min. and the maximum speed 164 m.p.h. Landing speed for planes *A* and *B* is identical—65 m.p.h A reduction of transportation cost from 4 cents to 2.64 cents, that is by 34 per cent has brought a reduction of maximum speed from 174 m.p.h. to 164 m.p.h., that is by 5.74 per cent, and a reduction of rate of climb from 980 ft. per min. to 600 ft. per min., that is by 42.2 per cent. The operators specific problems will have to be considered when finally selecting one or the other of these two machines. The reduction of maximum speed is probably of no great importance, the lower rate of climb and the thereby determined lower ceiling of the plane might make plane *B* less desirable for routes which lead over high mountains or where take-off at high altitude is necessary.

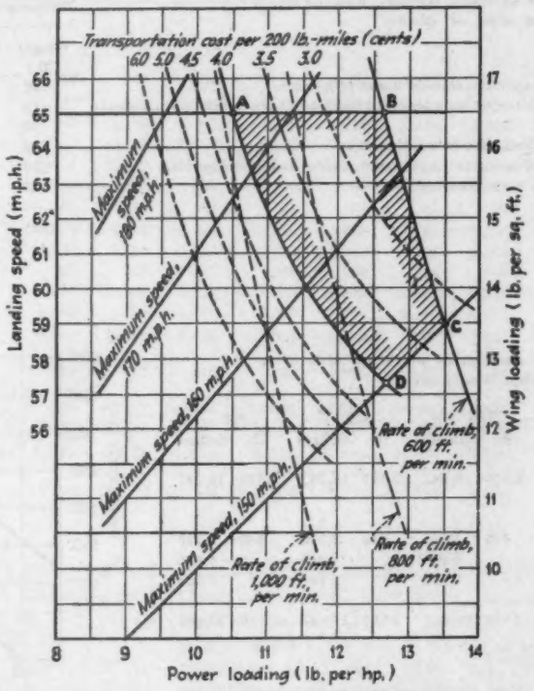

Transportation cost per 200 lb.-miles (cents)
60 5.0 4.5 4.0 3.5 3.0
Landing speed (m.p.h.)
Wing loading (lb. per sq. ft.)
Power loading (lb. per hp.)
Maximum speed, 180 m.p.h.
Maximum speed, 170 m.p.h.
Maximum speed, 160 m.p.h.
Maximum speed, 150 m.p.h.
Rate of climb, 600 ft. per min.
Rate of climb, 800 ft. per min.
Rate of climb, 1,000 ft. per min.
A
B
C
D

Fig. 5: Dependence of performance and transportation cost of a single-engined plane (575-hp. engine) on wing and power loading. 500-mile range.

Airplane *D* with a wing loading of 12.68 lb. per sq.ft. and a power loading of 12.68 lb. per hp. has the lowest landing speed—57.3 m.p.h. Its transportation cost is 4 cents per passenger-mile, its maximum speed 150 m.p.h., and its rate of climb 750 ft. per min. at sea level. Compared to *A*, which has same transportation cost, we find that the reduction of landing speed by 13.8 per cent is paid for by a reduction of maximum speed by 13.8 per cent and by reduction of rate of climb by 23.5 per cent. This must be considered as a very high price for slow landing speed.

Airplane *C* has the lowest landing speed with simultaneous lowest transportation cost. We can state, however, that its other performance characteristics are such that it is the least desirable of the group. The best average machine is probably to be found in the middle of the field formed by the lines connecting points *A, B, C* and *D*. It would have a wing loading of about 15 lb. per sq.ft. and a power loading of around 12 lb. per hp.

The analysis of the cost and weight of multi-engined planes is carried out in similar manner as shown previously for single-engined planes. The engines used are assumed to be the same as the one used on the single-engined type, that is air-cooled radial engines of 575-hp. normal rated power, and instruments and equipment are selected as required by the size of the plane and the number of engines used. Table VII gives the weight and cost of outside purchased parts of fixed weight and price, which parts are identical for all planes with the same type and number of engines, irrespective of the plane size.

A number of parts, manufactured by the maker of the plane, are identical for all plane sizes in the same way as has been discussed in the case of the single-engined plane. These parts of the power plant group of the twin-engined type have a weight of 300 lb. and an approximate cost of $1,300, and for the three-engined planes their weight amounts to 450 lb. and their cost to $1,950. Flying controls, pilots' seats, stabilizer adjustment mechanism in the cockpit, instrument panels and a number of various fittings and brackets in the cockpit, will weigh for the twin-engined plane with single control a total of 140 lb. and will have a cost of $800; for the dual control three-engined plane these parts will weigh approximately 230 lb. and will cost $1,100. To the cost price of these parts an amount of 20 per cent must be added to take care of sales expenses and net profit, and including this, the sales price of parts of the above two

Table VI: Dependence of performance and transportation cost of a 575-hp. plane on wing and power loading

Wing loading	16.5			15.5			14.0			13.0		
Power loading	9	11	13	9	11	13	9	11	13	9	11	13
Gross weight	5,170	6,320	7,480	5,170	6,320	7,480	5,170	6,320	7,480	5,170	6,320	7,480
Wing area	313	383	453	334	407	483	369	452	535	398	486	575
Maximum speed	183.5	171.5	162.5	179.5	168.0	159.0	174.0	162.5	153.5	169.5	158.5	150.0
Cruising speed	152.5	142.5	135.0	149.0	139.5	132.0	144.5	135.0	128.5	141.0	131.5	124.5
Rate of climb	1,350	875	550	1,380	910	590	1,420	970	645	1,460	1,000	675
Landing speed	65	65	65	63	63	63	60	60	60	58	58	58
Weight empty	3,450	3,700	3,970	3,500	3,800	4,075	3,650	3,960	4,275	3,760	4,090	4,430
Fuel for 500 miles	565	605	640	580	620	655	600	640	670	610	655	695
Pilot, oil, equipment	400	400	400	400	400	400	400	400	400	400	400	400
Payload	755	1,615	2,470	690	1,500	2,350	520	1,320	2,135	400	1,175	1,855
Total useful load	1,720	2,620	3,510	1,670	2,520	3,405	1,520	2,360	3,205	1,410	2,230	2,950
W_{UL} (payload and fuel load)	1,320	2,220	3,110	1,270	2,120	3,005	1,120	1,960	2,805	1,010	1,830	2,550
$\frac{W_{UL}}{hp.} \times V_{max}$	350	550	730	329	515	698	281	460	627	246	418	553
Sales price (dollars)	22,500	23,700	24,600	22,900	24,000	24,900	23,300	24,575	25,450	23,900	24,950	25,800
Sales price (dollars), per rated hp	39.15	41.20	42.80	39.80	41.70	43.30	40.50	42.70	44.25	41.60	43.40	44.90
Operating cost per hp.-hr. (cents)	6.900	7.060	7.175	6.950	7.100	7.220	7.000	7.175	7.280	7.100	7.225	7.330
Transportation cost per 200 lb.-mile (cents)	6.900	3.530	2.470	7.760	3.890	2.630	10.700	4.600	3.260	14.800	5.390	3.640

Table VII: Outside purchased parts of fixed weight and price, irrespective of type and size of plane.

	Twin-engined planes		Three-engined planes	
	Weight (lb.)	Price (dollars)	Weight (lb.)	Price (dollars)
Engines with carburetor, fuel pump, generator drive, primer pump, radio shields, metal propellers	1,950	12,500	2,925	18,750
Tachometers, oil and fuel pressure gauges, oil thermometers, altimeter, air speed and bank and turn indicators, compass	15	250	20	300
Fuel system parts	30	140	35	160
Landing gear parts, wheels with brakes, tires and tubes, tail wheel, oleo shock absorbers	250	500	360	900
Electrical system, battery, electric inertia starter, generator landing lights, instruments, cables and switches, etc	250	1,300	300	1,670
Miscellaneous equipment, fire extinguishers, first aid kits, safety belts, flare installation	40	80	50	90
Total	2,535	14,770	3,690	21,870
Handling charge and capital interest (10 per cent)	....	1,477	....	2,187
Sales price	....	16,247	....	24,057

Table VIII: Dependence of weight empty and sales price on size of a twin-engined plane (575-hp. engines)

Wing area (sq.ft.)	500		600		700		800		900	
	lb.	dollars	lb.	dollars	lb.	dollars	lb.	dollars	lb.	dollars
Outside purchased parts (fixed weight and cost)	2,535	16,247	2,535	16,247	2,535	16,247	2,535	16,247	2,535	16,247
Parts manufactured by plane firm (fixed weight and cost)	440	2,520	440	2,520	440	2,520	440	2,520	440	2,520
Cost of assembly work	.....	1,400	.....	1,400	.....	1,400	.....	1,400	.....	1,400
Development and tools	.....	1,500	.....	1,500	.....	1,500	.....	1,500	.....	1,500
Total fixed weight and cost	2,975	21,667	2,975	21,667	2,975	21,667	2,975	21,667	2,975	21,667
Weight and sales price of parts which change with size of plane	2,570	13,350	2,970	15,000	3,385	16,700	3,810	18,300	4,280	19,800
Weight empty	5,545	.....	5,945	.....	6,360	.....	6,785	.....	7,255	.....
Sales price	.....	35,017	.....	36,667	.....	38,367	.....	39,967	.....	41,467

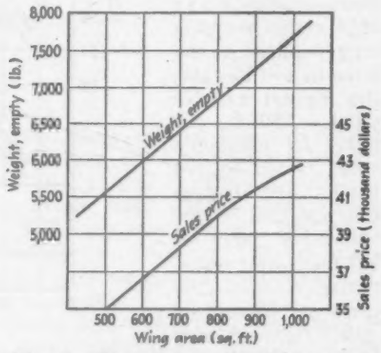


Fig. 6: Dependence of weight empty and sales price on size of a twin-engined plane (575-hp. engines).

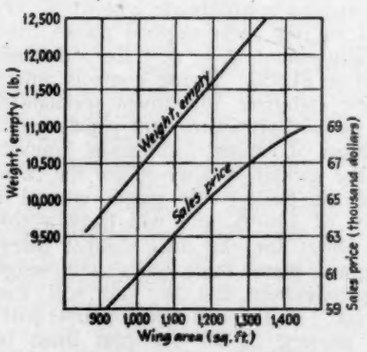


Fig. 7: Dependence of weight empty and sales price on size of a tri-engined plane (575-hp. engines).

Table IX: Dependence of weight empty and sales price on size of a tri-engined plane (575-hp. engines)

Wing area (sq.ft.)	900		1000		1100		1200		1300	
	lb.	dollars	lb.	dollars	lb.	dollars	lb.	dollars	lb.	dollars
Outside purchased parts (fixed weight and cost)	3,690	24,057	3,690	24,057	3,690	24,057	3,690	24,057	3,690	24,057
Parts manufactured by plane firm (fixed weight and cost)	680	3,660	680	3,660	680	3,660	680	3,660	680	3,660
Cost of assembly work	.....	2,000	.....	2,000	.....	2,000	.....	2,000	.....	2,000
Development and tools	.....	2,000	.....	2,000	.....	2,000	.....	2,000	.....	2,000
Total fixed weight and cost	4,370	31,717	4,370	31,717	4,370	31,717	4,370	31,717	4,370	31,717
Weight and sales price of parts which change with size of plane	5,450	27,000	6,030	29,200	6,600	31,400	7,230	33,400	7,830	35,300
Weight empty	9,820	.....	10,400	.....	10,970	.....	11,600	.....	12,200	....
Sales price	.....	58,717	.....	60,917	.....	63,117	.....	65,117	.....	67,017

Table X: Dependence of performance and transportation cost on wing and power loading of a twin engined plane (575-hp. engines)

Wing loading	16.5		15.5		14.5		13.5			12.5			
Power loading	8	9	8	9	8	9	8	9	10	8	9	10	10.5
Gross weight	9,200	10,350	9,200	10,350	9,200	10,350	9,200	10,350	11,500	9,200	10,350	11,500	12,075
Wing area	558	626	594	667	635	713	682	765	850	736	825	918	965
Maximum speed	185.5	177.5	181.5	173.0	176.5	168.5	171.5	164.0	157.5	166.5	159.5	152.5	150.0
Cruising speed	154.0	147.5	151.0	143.5	146.5	140.0	142.5	136.0	131.0	138.0	132.5	126.5	124.5
Rate of climb	1,550	1,350	1,600	1,400	1,650	1,450	1,800	1,400	1,150	1,850	1,500	1,250	1,150
Landing speed	65	65	63	63	61	61	59	59	59	57	57	57	57
Weight empty	5,800	6,075	5,950	6,250	6,125	6,500	6,300	6,675	7,050	6,550	6,925	7,325	7,550
Fuel for 500 miles	1,120	1,170	1,140	1,200	1,175	1,230	1,210	1,270	1,315	1,250	1,300	1,365	1,385
Pilot, oil, equipment	500	500	500	500	500	500	500	500	500	500	500	500	500
Payload	1,780	2,605	1,610	2,400	1,400	2,120	1,190	1,905	2,635	900	1,625	2,360	2,640
Total useful load	3,400	4,275	3,250	4,100	3,075	3,850	2,900	3,675	4,450	2,650	3,425	4,225	4,525
W_{ul} Payload and fuel load	2,900	3,775	2,750	3,600	2,575	3,350	2,400	3,175	3,950	2,150	2,925	3,725	4,025
$\frac{W_{ul}}{hp.} \times V_{cruis}$	389	483	361	450	328	408	298	376	450	258	338	410	437
Sales price (dollars)	35,900	37,100	36,600	37,800	37,250	38,600	38,100	39,400	40,700	39,000	40,300	41,600	42,200
Sales price per rated hp. (dollars)	31.30	32.30	31.80	32.90	32.50	33.60	32.20	34.30	35.40	34.00	35.20	36.20	36.80
Operating cost per hp.-hr. (cents)	6.160	6.230	6.200	6.280	6.250	6.325	6.300	6.375	6.450	6.350	6.440	6.510	6.550
Transportation cost per 200 lb.-mile (cents)	5.150	3.740	5.870	4.180	7.060	4.900	8.800	5.700	4.300	11.700	6.850	5.020	4.560

Table XI: Dependence of performance and transportation cost on wing and power loading of a tri-engined plane (575-hp. engines)

Wing loading	16.5			15.5				14.5			13.5		12.5	
Power loading	10	11	12	10	11	12	12.5	10	11	12	10	11	9	10
Gross weight	17,250	19,000	20,700	17,250	19,000	20,700	21,550	17,250	19,000	20,700	17,250	19,000	15,500	17,250
Wing area	1,045	1,150	1,255	1,110	1,228	1,338	1,390	1,190	1,310	1,425	1,280	1,410	1,240	1,380
Maximum speed	170.5	164.0	159.0	166.0	160.0	155.0	152.5	162.0	156.0	151.0	157.5	152.0	159.2	152.5
Cruising speed	141.5	136.0	132.0	138.0	133.0	129.0	126.5	134.5	129.5	125.5	131.0	126.0	132.5	126.5
Rate of climb	1,080	875	700	1,120	900	740	660	1,150	950	780	1,250	1,000	1,500	1,350
Landing speed	65	65	65	63	63	63	63	61	61	61	59	59	57	57
Weight empty	10,650	11,300	11,920	11,050	11,750	12,420	12,750	11,520	12,250	12,930	12,075	12,850	11,840	12,680
Fuel for 500 miles	1,830	1,900	1,960	1,875	1,950	2,000	2,050	1,925	2,000	2,060	1,975	2,050	1,950	2,045
Crew, oil, equipment	700	700	700	700	700	700	700	700	700	700	700	700	700	700
Payload	4,070	5,100	6,120	3,625	4,600	5,580	6,050	3,105	4,050	5,010	2,500	3,400	1,010	1,825
Total useful load	6,600	7,700	8,780	6,200	7,250	8,280	8,800	5,730	6,750	7,700	5,175	6,150	3,660	4,570
W_{ul} Payload and fuel load	5,900	7,000	8,080	5,500	6,550	7,580	8,100	5,030	6,050	7,070	4,475	5,450	2,960	3,870
$\frac{W_{ul}}{\text{hp.}} \times V_{cruis}$	484	552	618	440	505	567	594	392	453	515	340	398	227	284
Sales price (dollars)	61,900	64,200	66,200	63,400	65,700	67,500	68,200	65,000	67,100	68,700	66,600	68,500	65,900	68,100
Sales price per rated hp. (dollars)	35.90	37.20	38.50	36.80	38.10	39.20	39.60	37.80	39.00	39.90	38.70	39.80	38.20	39.60
Operation cost per hp.-hr. (cents)	6.485	6.575	6.670	6.550	6.695	6.720	6.750	6.620	6.710	6.770	6.680	6.760	6.650	6.750
Transportation cost per 100 lb.-mile (cents)	3.690	3.270	2.840	4.520	3.710	3.220	3.030	5.470	4.420	3.710	7.030	5.450	17.300	10.100

groups is $2,520 for the twin-engined planes and $3,660 for the three-engined types. The total weight of this group is respectively 440 and 680 lb.

The cost of assembly work, including all labor as outlined in detail for the single-engined plane, figures, including 20 per cent for sales expenses and net profit, to $1,400 for the twin-engined types and to $2,000 for the three-engined planes.

For engineering and developmental expenses costs of $1,500 and $2,000 respectively, have been assumed.

Weight and cost of parts of the planes which change with the size of the plane, as wings, fuselages, tail surfaces, cabin floors and walls, cowlings, etc., have been calculated in similar manner as has been outlined for the single-engined planes, and the results are contained in Tables VIII and IX.

When comparing the weights of parts which change with the size of the plane, as given in Tables VIII and IX, it will be found that the weight of these parts for a plane of 900-sq.ft. wing area is taken as 4,280 lb. for the twin-engined plane and as 5,450 lb. for the three-engined plane. This is explained by the fact that the 900-sq.ft. wing of the twin-engined plane would have to be designed for a wing loading of approximately 12.5 lb. per sq.ft., while the wing loading of the 900-sq.ft. wing for the three-engined plane would be about 17 lb. per sq.ft. A higher loading per sq.ft. wing area increases, of course, the size of structural members in the wing and thereby the weight. Furthermore, fuselages and cabin space as well as cabin equipment will be heavier for the three-engined plane, and the structural and installation requirements for the third engine give additional dead weight.

Figs. 6 and 7 show the values of Tables VIII and IX respectively, plotted over wing area.

Investigation of airplanes having wing and power loading combinations as given by the limitations of Fig. 2 (AVIATION, November, page 637) have been carried out in Tables X and XI. The basic performance requirements as stipulated in the beginning of this study are assumed to be in force. Range for all planes is 500 miles at cruising speed, the twin-engined planes carry one pilot, the three-engined ones carry a crew of two. Operation cost per hp.hr. and transportation cost per 200 lb.-mile, are calculated in the method as described in the study "The Economic Aspect of Transport Plane Design" (AVIATION, October, 1931).

Figs. 8 and 9 show the values of transportation cost

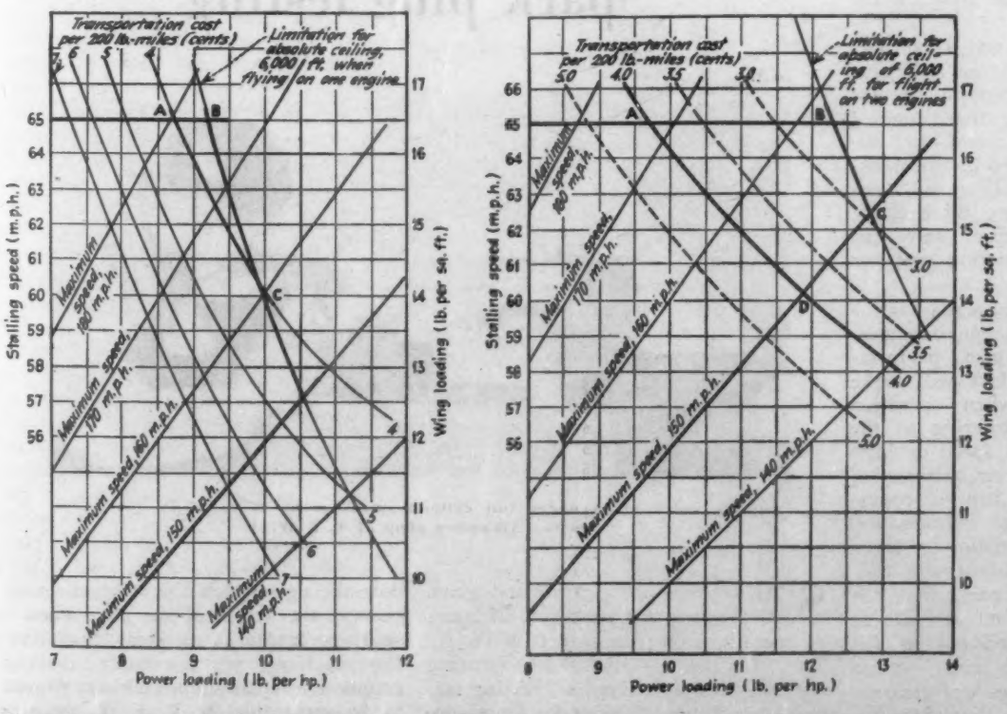

Transportation cost per 200 lb.-miles (cents)
Limitation for absolute ceiling, 6,000 ft. when flying on one engine
Maximum speed 180 m.p.h.
Maximum speed 170 m.p.h.
Maximum speed 160 m.p.h.
Maximum speed 150 m.p.h.
Maximum speed 140 m.p.h.
Stalling speed (m.p.h.)
Wing loading (lb. per sq. ft.)
Power loading (lb. per hp.)
Transportation cost per 200 lb.-miles (cents)
Limitation for absolute ceiling of 6,000 ft. for flight on two engines
Maximum speed 180 m.p.h.
Maximum speed 170 m.p.h.
Maximum speed 160 m.p.h.
Maximum speed 150 m.p.h.
Maximum speed 140 m.p.h.
Stalling speed (m.p.h.)
Wing loading (lb. per sq. ft.)
Power loading (lb. per hp.)

Fig. 8 (left): Limitations of wing and power loading for required performance and transportation cost of a twin-engined plane with two 575-hp. engines. Fig. 9 (right): Limitations of a tri-engined plane with three 575-hp. engines. 500-mile range.

as calculated in Fig. 6 and Table X and in Fig. 7 and Table XI, respectively, plotted in their relation to wing and power loadings, together with the limitations for performance. The values of wing and power loadings in the area formed by the curves connecting the points *A, B* and *C* in Fig. 8 give possible combinations for twin-engined planes equipped with two 575-hp. engines. The highest obtainable speed would be 180 m.p.h., indicated by point A, with a transportation cost per 200 lb.-mile of 4 cents; the lowest possible landing speed with a transportation cost of 4 cents and a maximum speed of 150 m.p.h. would be 60 m.p.h. The plane as indicated by the values of point *B* has the lowest transportation cost with the given performance limitations. In a similar way, limitations for three-engined planes are indicated in Fig. 9 by the curves connecting the points *A, B, C* and *D*.

Table XII: Lowest possible transportation cost for single, twin and three-engined planes

	Single-engined plane (575-hp. engine)	Twin-engined plane (575-hp. engines)	Three-engined plane (575-hp. engines)
Wing loading	16.50	16.50	16.50
Power loading	12.65	9.22	12.28
Wing area	440	642	1,285
Gross weight	7,260	10,600	21,200
Maximum speed	160.5	176.0	157.5
Cruising speed	133	146	131
Rate of climb	600	1,275	660
Landing speed	65	65	65
Weight empty	3,925	6,200	12,100
Useful load (total)	3,335	4,400	9,100
Useful load, per cent of gross weight	45.70	41.50	42.95
Sales price (dollars)	24,400	37,200	66,700
Sales price per rated hp. (dollars)	42.40	32.30	38.70
Operating cost per hp.-hr. (cents)	6.95	6.25	6.69
Transportation cost per passenger-mile (cents)	2.64	3.63	2.73

The possible field of wing and power loading combinations for the twin-engined type is very much smaller than the one for three-engined planes. It will be far more difficult to design a twin-engined plane so that is fulfills the given basic requirements as to performance and operating cost, than it would be to design a tri-engined plane for the same requirements.

A study of Figs. 5, 8 and 9 indicates that the single-engined type will give the lowest possible transportation cost per passenger-mile, the three-engined plane will be a close second, and the twin-engined type will be the most expensive one. Table XII gives comparative values for these three types, taking into consideration only the lowest possible transportation cost per passenger-mile.

While the twin-engined plane has the highest transportation cost per passenger-mile, it has also the highest performance figures and this fact will make the type interesting when operation conditions warrant a lowering of the economy to obtain high speed or high rate of climb. Other comparisons between the three types are of course possible, as for instance investigation of performance characteristics for given values of transportation cost.

It must be stated again, that the performance and weight, as well as price calculations carried out in this study, have been made under certain fixed assumptions. The performances as calculated by use of simplified formulas contain of course a certain possibility of error, which seems, however, to be within reasonably small percentages. It must be remembered also that the formulas used in these performance calculations were based on the assumption that the planes are designed with every attention to good streamlining and to best obtainable aerodynamic efficiency. If planes not falling in this class are to be investigated, the formulas must be revised accordingly, and landing and cruising speeds must be determined for the given condition. It must be pointed out in this connection, that the influence of speed appears twice in the calculation of the transportation cost per passenger mile, once when the amount of fuel for a range of 500 miles is being determined, and the second time when calculating the transportation factor.

After the approximate characteristics and limitations of the new plane types have been developed by the method outlined in this study, it is advisable to investigate further a group of planes so selected. This can be done by making exact performance calculations and weight estimates based on actual preliminary layouts of the various planes and by determining production costs for the selected type of design. If the planes are to be equipped with engines and instruments different from the types analyzed in this study, the tables of weight and cost of outside purchased parts have to be made up and weight and costs of other parts, as radiators, radio, pontoons, etc., have to be considered appropriately. Results of these calculations can be plotted in a similar manner as shown here, and the final selection of the optimum type will be easy. It is believed, however, that the method outlined here gives valuable information for the determination of approximate plane characteristics and that the visualization of performance and transportation cost curves serves to weigh one factor against the others.

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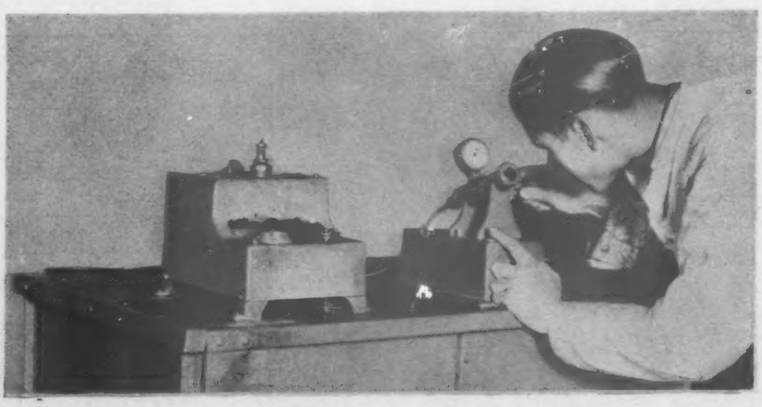
Spark plug testing



Testing spark plugs under full cylinder pressure of 65 to 70 lb. per sq.in. in the Alhambra shop of T. & W. A.

SPARK plugs are cleaned and given an operating test after each 24 hours of operations on planes of T. & W. A., Inc. This is accomplished by placing the plugs one at a time in a testing machine which puts them under a pressure of 65 to 70 lb. per sq.in. The firing chamber is equipped with a glass window through which the mechanic may observe the action of the plug when a sparking current is supplied. Such testing machines are commonly used in automotive repair shops and have proved to be invaluable in T. & W. A. aircraft engine servicing as they eliminate guesswork from spark plug servicing.

Transport

OPERATIONS AND TRAFFIC MANAGEMENT

Airline cards in hotel rooms

IN REPLY to the traveler who contends he prefers to take a sleeping car between points of call rather than consume any part of his business day in making the trip by air, Century Pacific Lines has placed under the glass tops of bureaus in the guest rooms of many hotels a card bearing the legend: Why not stay tonight in a comfortable hotel room and take Century Pacific Lines plane in the morning?

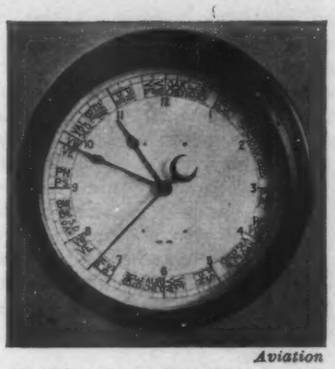
Rates and schedules, of course, are obtainable from the hotel porter. The company considers that these cards have been very effective traffic promotion media, especially as there are late afternoon, early evening and early morning planes which accommodate the traveler, particularly the salesman, with minimum interference with business hours.

Lettered clock faces for radio control

A SERIES of synchronized electric clocks installed in radio dispatching rooms of United Air Lines has simplified radio control of airplane movements. The clock face measures about 18 in. in diameter; around the rim the minute segments are lettered at one or two minute intervals with the abbreviation of a division of the airline. The minute hand successively designates the portion of the line over which radio communication is to be permitted, thus eliminating the possibility of garbling messages because of two or three conversations being attempted at the same time.

Thus, in any one hour there are four times when conversation may be held with planes on each section of the entire division, once every fifteen minutes. In addition there is one blank minute in every five-minute period for emergency communication or calls of a non-routine nature, and there is a two minute period in each ten minutes during which direct station-to-station communication is permitted. Since each airline is assigned but a single frequency upon which to broadcast, it is apparent that, with the great range of the present sending and receiving sets, some such system is essential to successful communication.

Abbreviations on the clock indicate: Boeing — Eastbound, Boeing — Westbound, Pacific Air Transport—Northbound, Pacific Air Transport—Southbound, Varney Air Lines—Eastbound, Varney Airlines—Westbound, and station listings such as Oakland-Cheyenne, Cheyenne-Oakland, Seattle-Oakland and San Diego-Oakland.



Aviation

Electric clock installed in all United Air Lines dispatching offices in order to control time of radio broadcasts to planes in flight

New portable steps for passengers

AN ADDITION to its conventional portable stairs has been introduced by Varney Air Service to make boarding or leaving its planes easier for the passengers. The addition is a sort of gangplank which extends out over the low wing of the Lockheed Orion from the top step of the portable stairs to the door. This obviates the necessity of stepping on the wing itself and provides rails for the passenger to grasp. The gangplank is slid back onto the regular steps when not in use. It protects the plane, speeds the loading and unloading operations and is easy to handle; it has been in use on the high speed service operated between San Francisco, Sacramento and Los Angeles.

Eastern's hostess system

YOUNG women were installed as hostesses on the Condors operated by Eastern Air Transport, Inc., between New York and Richmond late in 1930 to test out the advisability of employing them as regular members of the crew. Since that time the hostess service has proven so popular with passengers and so satisfactory to the company it has been made a permanent feature.

One factor behind the beginning of the service was the belief that a greater volume of women passengers would result from having women as members of the crew. This has been found to be entirely correct; a larger percentage of passengers than before are women. The other factor was that the presence of a woman attendant would more accurately carry out the general plan of the service and equipment, give the passenger the maximum ease of mind, especially on his first flight, and impress all with the fact that flying is not a hazardous undertaking.

The young women selected are put through a period of intensive training before going into service. For a few months there were many changes in the personnel until women suited to the position were secured. E.A.T. has a file of several thousand letters from its passengers commending the service generally and especially mentioning the helpfulness of the hostesses. The service is now in charge of Mrs. Ann Porter Cullman.

Aviation

The Varney "gangplank"

Flying Equipment

THREE NEW MILITARY PLANES

THE three machines shown in the accompanying illustration, are among the groups which have recently been delivered to the Army Air Corps for experimental or regular service.

The Keystone B-5-A bomber is the latest development of the well known LB-6 type, first developed for the army in 1927. It is designed for long range operation with heavy bombing loads and is powered with two Wright R-1750 engines. A series of ten service test airplanes of a similar size and type, known as the YIB-4 and YIB-6, powered respectively with Pratt & Whitney R-1860's and Wright cyclone R-1820-E's have also been delivered. All these machines are designed to carry a crew of five men, a bomb load of 2,200 lb., three flexible machine guns, and service type radio equipment.

The two-place biplane is the new Curtiss Falcon, also a development from earlier types, but carrying a number of refinements both in power plant and in external arrangements. The machine is designated as the O-39 observation type, and is powered with a Conqueror direct-drive prestone-cooled engine. Improved performance has been obtained by careful attention to streamlining the undercarriage, the engine cowling and radiator mounting. The machine shown in the photograph has been equipped with a special enclosure over the cockpit for executive use.

The third machine is a relatively new type of low wing bombardment airplane, designed for high speed over long ranges. It was built by the Boeing Airplane Company of Seattle, Wash., powered with two Pratt & Whitney Hornet engines of 575 hp. each. The airplane is to be designated as the B-9. It carries a crew of four men; a gunner-bomber in the nose, a pilot aft of him, and two men in the rear cockpit—a gunner-pilot, and a radio operator. The undercarriage is fully retracting into the lower surface of the wing.

Air Corp

The new Curtiss Falcon

Air Corp

Right: Low-wing Boeing bomber
Below: The Keystone B-5-A

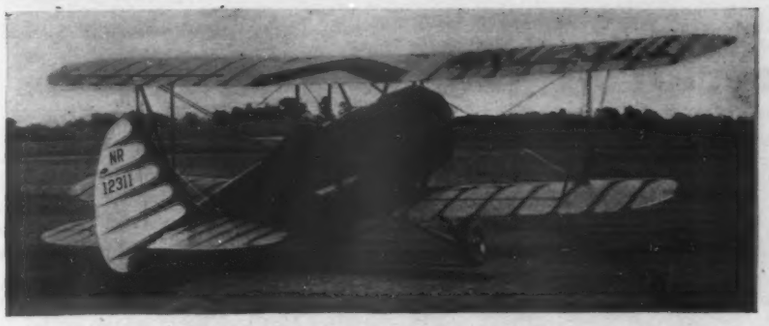
Air Corp

SOVIET ANT-14 TRANSPORT

SOME specifications are available on the new Soviet transport airplane (page 621, AVIATION, November, 1931) designed and built by Soviet engineers as the first unit on a line to connect Moscow with the Far East.

The machine is a high wing, full cantilever monoplane powered with five radial air-cooled engines, four of which are mounted in the leading edge of the wing and the fifth in the nose of the fuselage. Each engine is rated at 480 hp., giving a total of 2,400 hp. for the machine. Fuselage, wing and tail surfaces are built entirely of duralumin, and the landing gear is of chrome molybdenum steel tubing. Engine mounts are also of welded steel tubing and are demountable from the wing structure.

The arrangement of the cabin and pilot's cockpit follows modern transport practice. Seats for 32 passengers are arranged in the three sections of the cabin. The usual toilet and baggage accommodations are provided, and the cabin is arranged so that it may be equipped for night accommodations with minor changes. Heating and ventilating equipment are provided. The pilot's cockpit is located ahead of the cabin on a level with the leading edge of the wing. Space is provided for two pilots and a radio operator. As in the Do.X, a separate engine room



The Curtiss-Wright three-place biplane

is provided for a mechanic and the engine operating and instrument equipment. An electrical signal system between the latter compartment and the cockpit provides means of communication between pilots and mechanic. The heating and fire extinguishing equipment is also controlled from the engine room. The general specifications of the machine are:

Span	125 ft.
Length	78 ft.
Wing area	2,700 sq.ft.
Gross weight	39,600 lb.

BREEZE JUNIOR MONOPLANE

A SIDE-BY-SIDE two-place open monoplane of conventional parasol type has been tested by the Breese Aircraft Corporation, Portland, Ore. Powered with the Szekely 45-hp. engine the plane has been flown on a demonstration tour of the entire Pacific Coast territory.

The fuselage is of rigid steel tube construction, the wings are of spruce with built up spars, and fabric covering is used throughout. Airwheels are standard equipment on a rigid truss landing gear, with Rusco type shock absorbers optional at extra cost.

Span	36 ft. 6 in.
Length	21 ft. 0 in.
Wing area	152 sq.ft.
Gross weight	900 lb.
Weight empty	450 lb.

CLUB PLANE BY FORD

A SPECIAL model Ford monoplane was recently shipped to Manchester, England, for demonstration purposes by pilots of the Ford Motor Company, Ltd., in Great Britain and on the Continent. The airplane was notable on account of its attractive interior arrangement and decoration done in an English hunting scene motif, with color scheme in brown, green and tan, to carry out the effect. Club type reclining chairs for six persons and a divan for three constituted the seating equipment. Extra

The Breese Junior

luggage and locker space, as well as full toilet equipment were made available.

The machine was of the recent high speed type with completely faired undercarriage and equipped with ring cowling around the three Pratt & Whitney Wasp engines. Auxiliary gasoline tanks to permit long tours were also installed.

CURTISS-WRIGHT THREE-PLACE

THE Curtiss-Wright Airplane Company of Robertson, Mo., has recently announced a new three-place open land biplane, designed primarily for sports purposes, but which may be readily adapted to mail or cargo use by closing over the forward cockpit. The machine is a conventional type staggered biplane of relatively clean external appearance, being free from unfaired external projections. Considerable attention has been given to the streamlining of the undercarriage and to the provision of generous fillets where the lower wings meet the fuselage. A full cowl of the N.A.C.A. type surrounds the 400-hp. Wright Whirlwind air-cooled engine. Hamilton Standard metal propeller is regular equipment. The general specifications:

Span	31 ft. 0 in.
Length	23 ft. 2 in.
Wing area	247 sq.ft.
Gross weight	3,000 lb.
Weight empty	1,925 lb.

What Our Readers Say

Ring Cowling

TO THE EDITOR:

On page 521 of the September issue of AVIATION, there is a reference to recent experiments concerning the possibility of applying the principle of the Ring to other parts of aircraft than the radial engine. You suggest in particular two parts amenable to this kind of treatment, namely, (1) windscreens and (2) wing roots. On this subject, I would like to draw your attention to my original report on the Ring (R. & M. No. 1267) where, amongst other applications of the Ring principle, the above cases are mentioned, and experiments described showing that a reduction in resistance accompanies the use of aerofoils employed in the manner suggested.

A little more detail of the application to wing roots is given in the *Journal of the Royal Aeronautical Society* for October, 1930. Although an appreciable reduction in drag was obtained it was not as great as that obtained by filleting the wing-body junction in the now usual manner.

Later in the same number of AVIATION the sketches you show of the application of aerofoils to a cabin monoplane windscreen indicate that the principle is now being more widely recognized than hitherto. The ring-aerofoil may be likened to a signpost placed at a corner to tell the air where to go and as such it is necessary that its attitude should also take account of where the air is coming from. If it is not properly placed it will be ignored, for the air, though it may be coaxed, cannot be coerced, and the result will be confusion worse confounded.

It is gratifying to find that this principle is being increasingly utilized. I have given some further examples of it in the Royal Aeronautical Society Journal for August, 1931 (and in R. & M. 1394).

H. C. H. TOWNEND
Teddington, Middlesex, England

Aircraft at Work

$1,000,000 in cash flown to Virginia bank

A J-6 Travel Air was chartered recently by the First National Bank of Danville, Va., to import $1,000,000 in $5, $10, and $20 bills from the Federal Reserve, the First National, and Merchants National banks in Richmond. The flight was made as a demonstration of the effectiveness of aircraft for such shipments and of the resources of the bank. It was not occassioned by any emergency need for cash, though it is obvious the airplane might easily be used to advantage in such emergencies.

The currency was packed in five canvas bags the whole shipment weighing about 500 lb. The plane was surrounded by a police cordon on landing at the airport where the money was transferred to a limousine, the police escort remaining with the shipment until it was safely deposited in the bank vaults. The flight from Richmond was made in an hour and 35 minutes and the trip from the airport to the bank in about ten minutes.

Planes sow rice in southern California

THE majority of rice sowing in southern California is now done by airplane instead of conventional methods. One operator, Col. L. G. Irving, has twelve machines on this work during the six weeks when planting is done. This period precedes the crop and tree dusting periods and practically the same equipment is used. Each plane can plant between 200 and 300 acres per day, applying seed at the rate of 100-170 lb. per acre, according to the type of seed and soil.

Profit under normal conditions is about one-third the gross income. The charges for sowing are 75 cents, 90 cents and $1 per acre for the three methods—flying in one direction only, flying back and forth, or flying criss-cross, respectively. Sowing is done during daylight hours with the exception of two hours in mid-day when air conditions usually are not favorable. Each plane makes 60 to 80 landings per day and the engine is stopped only at noon and at the close of the day. Fueling is done while the engine is idling during the loading of seed to save time.

Rice planting is very exacting as the contract requires an even sowing. Usually about 4 in. of water covers the fields to aid the germination of the seeds. Besides rice planting, and crop and tree dusting, the planes are used in oil spraying of swamp areas, re-seeding grazing lands and spreading chemical fertilizers.

Mamer plane carries forest fire fighters

A FORD transport was used effectively last season by Mamer Air Transport, forest fire patrol contractor in the Northwest, to carry government fire fighters and their equipment from Spokane to fires in Idaho and the Nez-Perce Forest. The trips, made in about two hours by plane, would have required four or five days by other means of transportation into the remote forest regions.

(Left to right) John Fornasero, pilot, P. A. McDonough, photographer, and T. Claude Ryan, president of the T. C. Ryan Aeronautical Company, examining a Hugershoff camera before its installation in the Fairchild monoplane used in mapping Death Valley for the U. S. Department of the Interior.

The transport carried 300 men and their equipment and 60,000 lb. of miscellaneous equipment and supplies. The seats were removed to make possible a maximum load of between 2,500 and 3,000 lb. Sometimes it was necessary to climb to 14,000 ft. to clear mountains or clouds of smoke. There were no serious accidents despite the difficult and hazardous operating conditions.

Two landing fields in the forest region were used; one is the Chamberlain Station Meadow Field in the Idaho National Forest, 6,000 ft. above sea level, and the other is at Moose Creek in the Selway National Forest. The latter was built by the Forest Service for the use of cooperating aircraft. It is 1,700 ft. long and surrounded by mountains and tall, dense timber.

Death Valley mapped under severe conditions

FOR the first time the United States government has made an aerial survey the famous Death Valley in Inyo County, Cal. The area has been mapped roughly at various times but no two maps agree and the inaccessibility of the valley makes aerial survey much more effective than a ground survey could be.

Under a contract with the Geological Survey of the Interior Department, the T. C. Ryan Aeronautical company of San Diego has completed the air mapping of a strip comprising 400 sq.mi., 50 miles long and 8 miles wide.

The combination of intense heat and neighboring mountain ranges with their cooling influence on the air produced difficult air conditions which conspired against the high degree of accuracy required. A variance of only 2 per cent in altitude of the plane was allowable. The floor of the valley is 274 ft. below sea level and the summer temperature reaches 130 deg. F. The adjacent mountains rise to 6,300 ft. above sea level and at the 15,000-ft. altitude at which the plane was flown the temperature averaged 65 deg. Beside the bumpy air, these conditions caused troubles in keeping within the maximum overlap of 50 per cent and minimum lap of 20 per cent, as the angular extension of the lens from the

15,000-ft. altitude often covered the low elevation on one side and intercepted the extreme high elevation on the other side.

The available ground survey maps, some of them 40 years old, were pieced together for data but a definite fix, or starting point, had to be secured by a preliminary air survey. The company used a Whirlwind Fairchild equipped with a Hugershoff aerial camera mounted on the floor of the cabin and aimed through an aperture in the floor. John B. Fornasero, chief instructor at the Ryan school, was pilot, and P. A. McDonough, veteran of the Navy's 1926 Alaskan Mapping Expedition, operated the camera.

AIR NAVIGATION, *by Lieut. Comdr. P. V. H. Weems, U. S. N.; McGraw-Hill Book Company, New York; 1931; 589 pages; $5.*

WRITING a criticism of a book on navigation by Commander Weems is like trying to introduce Will Rogers to an American audience. Everything that can be said is already universally known. The name of Weems has been synonymous with the last word in the navigational art for the last three or four years.

The present volume brings his ideas up to the minute. Its major part is of course devoted to celestial navigation, which is Commander Weems' real specialty. He does not by any means, however, confine himself to that. Dead-reckoning, map reading, use of the compass, aids to air navigation both visual and radio, and meteorology are all covered. The treatment of celestial navigation assumes that the reader knows nothing except high school mathematics, and starts him off with the explanation of what the heavenly bodies are and where they are located, to carry on through all the details of practical position-finding from sun, moon, or stars. It should be easy for any intelligent reader to follow, for the style, while no means brilliant, is workman-like, careful, and clear.

THE NAVIGATION OF THE AIR AND METEOROLOGY, *by Capt. Leslie S. Potter, Harper & Bros.; 1931; 233 pages; $4.*

CAPTAIN POTTER'S book corresponds to one-half of that of Commander Weems'. Celestial navigation is completely ignored, but ordinary pilotage, dead-reckoning, and meteorology and radio are handled much as in the larger volume. Captain Potter's treatment is perfectly competent, extremely simple, and quite adequate for the pilot with no ambitions to make long over-water flights or attack other navigational problems of extreme difficulty. He has contented himself with the briefest possible explanations and a complete elimination of theory. For example, Captain Potter gives only two pages to the radio beacons, where Commander Weems devotes six in much smaller type, but the smaller volume no doubt gives as much information as the average novice pilot cares to possess. It is essentially a ground-school text.

AROUND THE WORLD IN EIGHT DAYS, *by Wiley Post and Harold Gatty; Rand McNally & Company, New York; $2.50.*

THIS is the detailed record of that remarkable flight of the *Winnie Mae* around the world June 23-July 1 last summer. To a world which speedily forgets some of the best work of its pioneers is preserved in this volume the whole story of one of the greatest flights yet accomplished, garnished with many intimate details which have so far not been general knowledge. One is impressed all over again with the background of skill, painstaking thoroughness in all items, and general caliber of the men, which made victory possible in the face of extremely unfavorable conditions.

THE AIR ANNUAL OF THE BRITISH EMPIRE 1931-32; *Gale & Polden, Ltd.; London; (American agent, Wm. Dawson Subscription Service, Toronto); 651 pages; 21/-net.*

IN size and general appearance, the third volume of the British Air Annual is like its predecessors, and it maintains the same generally high quality in that portion of the contents which is really original. As usual with such annuals much space is devoted to essays of somewhat elementary tone, bringing little new information to specialists in the field. Among the articles in the current volume to which that criticism does not apply, and which deserve careful attention, are "The Economic Function of Imperial Air Services," "The Future of British Aircraft Trade Within the Empire", "The Principle and Applications of the Townend Ring" by Mr. Townend, and "A Comparison Between Aircraft Structural Strength Requirements of Great Britain and Other Countries" by A. E. Russell. The last essay is of extraordinary importance, the first really exhaustive study of the kind that has been published.

There are also admirable surveys of military and civil development, the former by Maj. Oliver Stewart, AVIATION's British correspondent, and of the work of the British industry during the year. Fifty pages are devoted to individual descriptions of military machines, classified by function, and twenty-five pages to a similar treatment of civil planes. The complete absence of any section on airships is noticeable. The lively interest of the British industry in foreign trade is symbolized by the incluson of a French and a Spanish appendix, each of about 100 pages, summarising the content of the book.

INTERNATIONAL AIR GUIDE; *Imprimerie Crété; Paris, 1931; 900 pages; $15.*

THIS is the sort of book that used to appear in Leipzig, and now comes from Parisian presses. No American publisher, confronting American printing costs, can understand its economics. Printed in three languages, it includes descriptions and schedules of all the air transport companies of the eastern hemisphere, with a complete index of rates of fare, statistics upon notable flights, tabulations of world's records, lists of flying schools, reprints of international air conventions and other legal documents, and finally a perfectly staggering amount of material on airways and airports.

There are maps galore for the sole purpose of showing the meteorological and radio organization along the well-travelled routes. There is a map of each country for the same purpose (although the usefulness of those charts for the casual readers is reduced by the cleverness with which the explanations of the map symbols have been hidden away at a considerable distance from the maps themselves). There are 500 pages of airport information, with the same sort of data that is given in the Commerce Department's airport circulars and with location maps and large-scale maps of each of the important fields. Although the amount of useful information given is tremendous, the arrangement is somewhat unfortunate. It is purely alphabetical without reference to national boundaries. Bar-le-duc, in France, for ex-

ample, is inserted between Bangkok, in Siam, and Barcelona, in Spain.

The book concludes with a collection of strip maps on folded inserts, 65 in number and in three colors, covering all of the important routes of Europe. As is the fashion with European annuals, there is a large amount of highly miscellaneous advertising, scattered all through the volume and all over both covers. It serves to increase the weight to about 5 lb. As a work of reference for any Americans who may be planning to tour Europe by air the International Air Guide will be of immense value, but except for that very limited group its purchase would be hardly worth while.

GLIDING AND SOARING, *by Percival White and Mat White; McGraw-Hill Book Company; 234 pages; $2.50.*

THE ideal book on gliders for the novice is yet to be written. This, though it possesses some excellent features, is not the one. The explanations are simple, and illustrations are copious, both by photographs and by excellent sketches, but simplification is sometimes carried to apalling lengths, and the vocabulary used suffers, as with that of many glider manuals, from arbitrary and absolutely literal translations from the German.

THE AIR WEAPON, A HISTORY OF BRITISH MILITARY AERONAUTICS, VOL. I, 1783-1914, *by C. F. Snowden-Gamble, Oxford University Press, London, 290 pages; $4.50.*

MR. SNOWDEN-GAMBLE'S powers as a historian of military aviation had already been made plain in his "Story of the North Sea Air Station." For several years now he has been laboring upon the preparation of the first great history of military aviation, the first volume of which is before us now. Although it nominally covers only British experience, the military activities of the various countries of Europe have been so intertwined that there is necessary mention of much that was going on on the continent.

The first volume finds itself concerned largely with ballooning, roughly one-half of its extent covering the period before the first serious attempt to organize an airplane unit in the British Army. The latter section of the book will of course be more interesting to officers of the present-day Air Corps and naval aviation. The next of the series, promised for the near future, and destined to cover the period of the World War, will be even more important to the practical member of the military aeronautical profession. Mr. Snowden-Gamble has done a perfectly tremendous amount of historical and literary research, especially in digging out previously unknown references to the earliest military usage of balloons, and he has been remarkably successful in the difficult task of keeping a proper balance among all the phases of military flying and air force organization, tactics, development of piloting technique, material progress, and personnel problems.

THE WAR IN THE AIR, THE OFFICIAL HISTORY OF THE PART PLAYED BY THE ROYAL AIR FORCE IN THE GREAT WAR, VOL. III, *by H. A. Jones; Oxford University Press; 443 pages, 42 maps; $9.*

NATURALLY, Mr. Snowden-Gamble's book, just reviewed, overlaps to a large extent the official British history of the war in the air. One is prone to think of an official history as being necessarily a heavy and tedious volume, but there has been nothing of that in the series so well begun by the late Sir Walter Raleigh and carried on through its second and third volume by Prof. H. A. Jones. The official historian fulfills an indispensable role, but however light his touch he does labor under two disadvantages as against the writer responsible only to himself and to his publisher. The writer of the governmental version, working directly from the archives, has little freedom in expression of opinion and must confine himself to reporting, with but little interpretation. Furthermore, because his is to be the great official record it must be enormously documented with innumerable names and a great mass of data. As a result, however attractively written, it assumes a bulk staggering to all but the enthusiastic student of history or the air force officer exceptionally keen upon the study of his profession. The present volume, the third of the series, brings the war up to the early part of 1917, and will presumably be followed by one or two more.

The arrangement is not strictly chronological, but by campaigns. The bulk of the third volume goes to discussion of the German air raids on England and to a general treatment of administration, recruitment, training, and the supply of equipment in the first two years of the war. The section on the air raids, which is accompanied by 42 large maps plotting every raid in detail, should be closely studied by every air corps officer. The section on supply and equipment, accompanied by many tables showing the exact rate on which deliveries were made on every type of airplane and engine, ought to have equally close attention from airplane manufacturers, from those in the War and Navy Departments who are responsible for procurement of air equipment and for "industrial preparedness," and from any Congressmen, newspaper editors, or others who fancy that air force equipment and an aviation industry can be extemporized over night.

HISTORY OF AIRCRAFT, *by Prof. F. Alexander Magoun and Eric Hodgins; McGraw-Hill Book Company; New York; 495 pages; $5.*

A YEAR and a half ago Mr. Hodgins and Professor Magoun entered the aeronautical world with "Sky High; a popular history of aeronautics." We have already paid tribute to its exceptional qualities in the columns of AVIATION. It commanded so much favorable notice that its authors have now been persuaded to produce a new volume on the same subject, but a volume somewhat less popular in type, considerably longer, much better illustrated, and considerably more exhaustive in detail in treatment of individual episodes.

The book is without bias as between the various types of aircraft. The early days of the spherical balloon, the development of the airship, and ornithopter, helicopter, and airplane are all given their due of space. Although the touch is not so light as in "Sky High" (the search for historical completeness barred that), the book is still one that can be read with the greatest pleasure and profit by anyone connected with aviation who feels even the slightest curiosity about the historical background of his own activities. It is particularly commendable on the score of freedom from national prejudice. Previous aeronautical histories of European origin have been specked with cheap flings at American accomplishments, American vocabulary, and whatnot. Messrs. Magoun and Hodgins have preserved the impartiality of true historians, and have recorded the great achievements of American, British, German, French, or Italian pilots and engineers with equal warmth.

NATIONAL REGULATION OF AERONAUTICS, *by Charles C. Rohlfing; University of Pennsylvania Press; 298 pages; $3.*

PROFESSOR ROHLFING has written a book with a minimum of intrusion of the author's personality. He has diligently compiled and classified the facts on federal and state regulation, Department of Commerce policy on accident publicity, and other kindred matters. Where opinions are given, they are not the author's opinions, but those of some authority whom he cites. Where an issue is controversial, he has striven to give competent representation of both sides. Quotations are taken not merely from official sources but from newspapers, addresses before engineering societies, articles in the aeronautical press, and editorials in AVIATION. The elaborateness of the documentation is evidenced by the fact that the book contains 500 footnotes, almost two per page, along with fifteen pages of general bibliography.

Servicing Short Cuts

A PORTABLE PAINTING CABINET

FOR miscellaneous painting jobs such as touching up, striping, applying license numbers, or special owner's markings on airplanes, the paint crews of the Lockheed Company at Burbank, Cal., have found that a portable painting cabinet offers much in the way of convenience.

A simple wooden cabinet mounted on castors contains a compartment for about 70 ft. of main line air hose and 50 ft. of small hose for spray gun use. A separator is permanently installed in the main air line to remove moisture and impurities from the compressed air. Compartments are provided for a small stock of paints of various colors, mixing trays, brushes, spray gun equipment and the necessary stencils and masking paper.

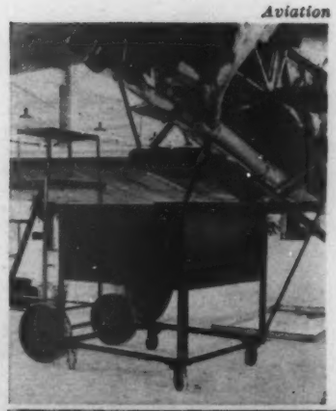
TANKS FOR ENGINE DRAINAGE

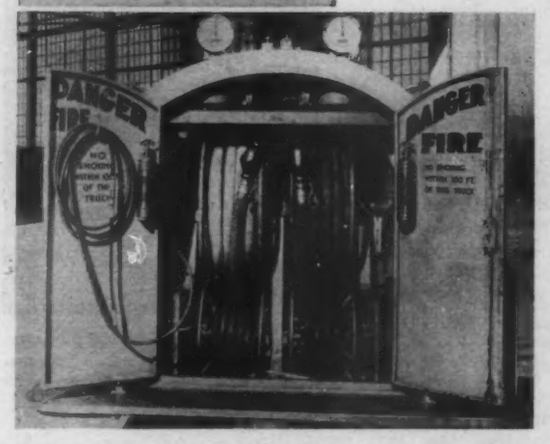
PORTABLE tanks for receiving lubricating oil drained from aircraft engines are to be found in practically every hangar and repair shop, but are subject to almost endless variation in form, depending on the ideas of the local operating people. The equipment used in the Seattle shop of the United Airline for this purpose is shown in the accompanying illustration. The broad tank with the open top eliminates the use of a funnel and the need for accurate placing of the receiver below the engine. Shallow extension pans may be attached to the main receiving tank to act as drip pans when cleaning up the outside of the engine. Thorough cleaning may then be accomplished without the excess cleaning compound dripping on the hangar floor. A drain plug and a flexible hose in the bottom of the tank facilitate running the used oil into a storage tank.

Aviation

E.A.T. leveling stand

Aviation





Upper: Portable oil drainage tank used by United Airline at Seattle. Lower: Fueling unit at Burbank.

LEVELING STAND FOR RIGGING

THE Atlanta Repair Depot of Eastern Air Transport, Inc., uses a simple and inexpensive stand produced in their own shop to support Pitcairn Mailwings in flying position during rigging. A well-braced welded steel tube framework is surmounted by a small screw jack. A cast-iron block, suitably recessed to take the end of the airplane's tail post is fastened to the platform of the jack. Placing the tail post on the jack, puts the airplane in approximate flying position, and the final accurate leveling-up is accomplished by adjusting the jack screw.

A TANK TRUCK FUELING UNIT

TO REDUCE the refueling and general servicing time for airplanes on the United Airport at Burbank, Cal., a specially-designed Moreland tank truck, having a capacity of 1,000 gal. each of two different brands of gasoline and 150-gal. capacity of each brand of lubricating oil, is now in use. The truck engine operates the pumping system which is of such a capacity that airplanes can be serviced at the rate of 30 gal. of gasoline and 15 gal. of lubricating oil a minute. The auxiliary equipment includes compressed air for tire inflation, a water tank and hose, fire-fighting apparatus, and various types of tools for emergency use. Fifty-foot lengths of hose for oil, air, or gasoline permit the servicing of any type of airplane.

HOLD DOWN WEIGHTS FOR RIGGING

WHEN leveling up a plane in flying position in the shop it is necessary that the tail be weighted down to prevent the possibility of nosing over. To eliminate the use of the usual miscellaneous assortment of sand-bags, heavy pieces of equipment, or other haphazard arrangements ordinarily used for this purpose, the Boeing Airplane Company at Seattle has developed a standard 100-lb. lead weight unit with a ring and a length of rope permanently attached. These are kept in convenient places around the shop where they can be quickly swung into position when needed. Conveniences of this character, although relatively simple, go a long way toward safe and economical operation.

Airport Management

Small fields consider landing fee revenue

AIRPORT operators in many sections of the country have much in common with those on certain Long Island fields whose revenue is affected by the presence of the larger and better known ports in the vicinity. The smaller fields are useful to the communities in which they are located and to the flying public, and make possible revenue producing trips from the larger fields. But they often are considered only convenient landing places and seldom the source of fuel, servicing or various cash transactions, because of the proximity of the larger fields.

The fields concerned recently held a conference regarding means of stimulating revenue for the smaller units. The medium suggested was the landing fee, inasmuch as landings are the greatest use to which the smaller fields are put. For obvious reasons the larger fields demurred from the imposition of a landing fee but it was the consensus of the conference that the smaller fields in such a situation might find the controversial landing fee just the thing to solve their particular problems. If it is ever justified, it is in such cases.

The upshot is that landing fees of not less than 50 cents and not more than $1.50 per landing may be invoked next spring for small fields used chiefly as points of call on pleasure operations—such as flights by parties to resorts, sporting events and country places—when neither fuel nor servicing is required. There should be some return for the convenience of the field, the courtesy of cranking the propeller and the minor attentions which assist the visiting pilot.

Mt. Hawley Airport policies successful

SPECIAL emphasis on non-professional activities and a generous policy toward commercial pilots has enabled Mt. Hawley Airport at Peoria, Ill., a typical commercial airport, to secure a profitable volume of business in recent months. While the margin of profit is not large it justifies operation of the port.

The policies provide: low hangar rent of $15 per month and sale of gasoline for 25 cents per gallon, instead of 30 cents per gallon, the prevailing rate in that section; provision of a modern steel and brick hangar capable of housing about 30 average size machines; elimination of all fees or commissions from commercial operators, the only requirement being the monthly hangar rent; operation as plane brokers handling all makes rather than attempting to represent one manufacturer; a low dead storage rate for aircraft the owners of which are unable to operate or wishing to sell, and free listing of the latter on the used plane market.

The airport clock on the administration building at Floyd Bennett Field, Brooklyn, N. Y.

Non-professional operators are attracted by the low rent and gas charges, and by the fact that a modern hangar is available for storage rather than makeshift buildings. The company believes that as a broker it can place all its sales effort on selling prospects the idea of flying rather than spending the usual effort on converting them to one make of plane. It is possible, also, to secure through the used or new plane market the particular machine the prospect has in mind. Six private owners now use the airport. General flying activities have increased as a result of the liberal terms granted commercial operators. This helps the airport in a number of ways, one of which is increased fuel sales.

Advertising of the advantages offered by the port is done through a 13½x21-in. illustrated folder mailed to all plane owners within 200 miles of the field. There are reproductions of two photographs of the hangar, and two sketches of the layout of the field and its location with respect to the city.

Portable traffic lights at United Airport

AN EFFECTIVE system of "Stop" and "Go" signals has been developed by United Airport, Burbank, Cal., for controlling air traffic at night. The field dispatcher is equipped with two 6-in. spot lights, one red and one green, each equipped with a 100-watt lamp. Each light is separately controlled by means of a trigger switch on the handle. The lights are attached to a 100-ft. extension cord so that the dispatcher can readily carry them to a point facing any of the five runways. The extension cord is divided 10 ft. from the handle of each light in order to permit them to be independently operated, and each lamp is provided with a hook to permit hanging it to the operator's belt when not in use.

In operating these lights, the field dispatcher, whose station is on the runway system near the depot loading station, walks out upon the runway system to whatever point is necessary in order to be seen from the head of any runway. The green light is flashed to waiting pilots when all is clear for the take-off. The red light is used to hold pilots back from taking off until the field is clear, or to warn taxiing planes that the runway is in use and must not be crossed.

Clocks on airport buildings

PROMINENTLY located on the tower of the administration building of Floyd Bennett Field, is a 36-in. face clock. It faces the field side, and may be seen for some distance along the two runways as well as from the broad concrete apron which extends along the entire hangar line. This clock has proven to be a great convenience to pilots, mechanics and spectators. It is a feature which few ports have provided but one which has a number of definite —and obvious—virtues.

The Buyers' Log Book

•

Pyrometer recorder

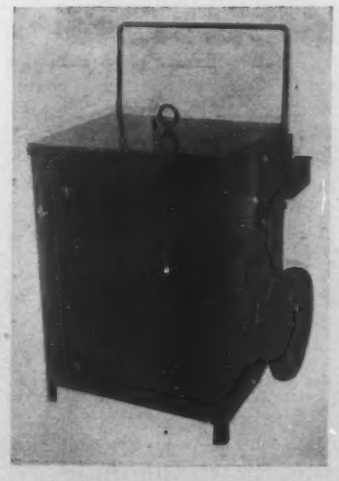
The Wilson-Maeulen Company of 383 Concord Ave., New York City, has recently placed on the market new models of the Tapalog pyrometer recorder. These instruments are designed to furnish a continuous record of temperatures in industrial furnaces of any type, and have been applied to a number of installations where aircraft parts are heat-treated. They can be furnished to operate on any alternating current electric power supply of 110-220 volt, 25-60 cycle. Models may be obtained to record from one to six separate temperatures simultaneously. — AVIATION, *December, 1931.*

Hangar floodlight

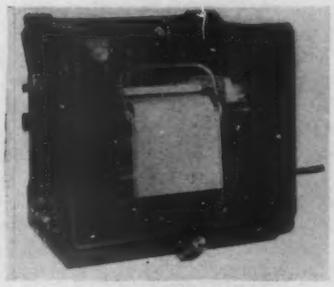
The General Electric Company, of Schenectady, N. Y., has recently announced a non-rusting, weatherproof airport and hangar floodlight known as the type ALF-2, designed to illuminate the approaches to buildings, aprons, and the interiors of hangars. The unit is equipped with a Fresnel lense and a 5-in. spherical mirror which gives a horizontal distribution of approximately 180 deg. and a vertical divergence of approximately 17 deg. A screw-base lamp socket is provided which will take either a 1,000-watt or a 500-watt Mazda lamp.—AVIATION, *December, 1931.*

Arc welder

An electric arc welder, the Flex-Arc, designed to operate on alternating current circuits has been announced by the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa. The equipment is fully portable, being mounted on wheels in a ventilated steel cabinet equipped with a convenient handle for pushing. The welding current is adjusted by means of four knife switches mounted on the outside of the cabinet. The current supply may be from any 110- to 220-volt, 50- to 60-cycle line, and the available welding current ranges from 8.5 to 125 amp. There are no moving parts.—AVIATION, *December, 1931.*



Westinghouse Flex-Arc welder



Wilson-Maeulen Tapalog

Hangar door

A new type side-winding steel door, especially applicable to aircraft hangars and industrial buildings, has been placed on the market by the Acme Partition Company, 3535 Peralta St., Oakland, Cal. Constructed of 16-gage vertical interlocking steel slats supported from an overhead track by ball bearing sheaves, the door is wind and dust proof. It may be manufactured in units offering a clear span 200 ft. wide and 30 ft. high to be operated either by hand or by electric motor. The door is built in two units, meeting at the center and winding upon a rotating disc at each side. It is held in place at the bottom by guides operating in a groove. The weight complete is 5 lb. per sq.ft.—AVIATION, *December, 1931.*

Surface hardener

A granular tungsten carbide material for producing very hard wearing surfaces on metal is being distributed by the Lincoln Electric Company of Cleveland, Ohio, under the trade name of Blackor. The material is powdered over the surface to be hardened and is fused into the metal by means of an electric arc welder. The finished surface has a scratch hardness of 9. One ounce of Blackor will cover 3 to 4 sq.in. of metal. A number of industrial applications have been made of the new material, among them the surfacing of tail skid shoes.—AVIATION, *December, 1931.*

Telepoint compass

The Pioneer Instrument Company of Brooklyn, N. Y., has recently put on the market a remote indicating magnetic compass, which, although differing in principle from the well-known earth inductor, may be used in exactly the same fashion by the pilot, to set and hold a predetermined compass course. The magnetic director, which is in effect a liquid rheostat controlled by a magnetic direction element similar to that used in the Pioneer Straightway Magnetic Compass, may be located in any part of the airplane which is free from local magnetic disturbances. The steering indicator, direction controller, and sensitivity adjuster are located on the pilot's instrument board. The course is set by the controller and deviations from it are indicated by the steering indicator. It is thus necessary only to steer the plane so as to maintain the steering indicator hand at zero. A typical installation weighs approximately 11 lb. complete when the magnetic director and the direction controller are connected by 10 ft. of flexible shafting.—AVIATION, *December, 1931.*

Side-winding steel hangar door

Side Slips

By ROBERT R. OSBORN

"HIS face was made up of smooth oblique planes, rather like the cowl of a ship, as if it had been chiseled so for speed and alert vision. His gray eyes under straight brows were set at what he would have termed a slight dihedral. He was tall and competent and taut, and there was a strangeness about him somewhat fascinating."—Description of a pilot discovered in *Liberty* by R.W.C. of Memphis, Mo.

It's the hard times what makes him look thataway, Lady. Now if you just had a dime for a cup of coffee——.

The Department of Commerce has so many variations of the pilot's license, nowadays, it's hard to keep up with them. Dick Pears, of Cudahy, Wis., sends in a clipping from the Green Bay (Wis.) *Press-Gazette* which mentions a new type of license which Dick says he's never going to apply for,—under "Airport Notes" is the item: "Ed K—— passed the examination for trans-Atlantic pilot's license."

Mr. T.G., our esteemed Chicago correspondent, reports that things are unusually quiet along that front, about the only amazing and unusual news he has to send in being a minor crash in which "an open circuit biplane" was involved.

Admitting that it is hard to get a crowd out to an airport these days, with times as hard as they are, nevertheless we do believe that it is possible to go too far in offering sensational attractions as inducements. For instance, we think the authorities should do some revising of a program reported in the New Haven (Conn.) *Evening Register*—"While the program has not yet been completed, it is proposed to include as part of the day's entertainment spot landing contests, time races, a bomb dropping contest and dead stick landings. Ed Sherman will drop from a parachute."

Thanks for the clipping to "The Flying Nutmeg" who comments that Ed would have a good chance of winning the spot landing contest.

A great advance toward safety has been made in a new light plane designed for the private owner, in that the word "Ready" appears on the instrument board when the engine heat is sufficiently high to take off. This is, of course, a step in the right direction, but we do think that further automatic advice is needed to make the airplane really safe for the private user. Such items as the following would not be out of place:

"The engine has stopped. We'd suggest you make a landing."

"Pardon us for mentioning it, but this unusual rotating motion of the plane is known as a spin. A spin is classed as a stunt by the Department of Commerce, and, as stunts are not allowed below a thousand feet over an airport, you are likely to be criticized by the local inspector. Please turn to page 13 of your instruction book for the approved method of recovery from a spin."

"The figure 0 appearing on the dashboard is not a trip mileage recorder, but indicates an acute shortage of gas."

There is a saying from way back in the days of Heywood Broun that "Fame is as fleeting as a ferry boat shoe shine," and its truth is often demonstrated. Not so many years ago the airplane pilot was the young god, the cream of the crop, the answer to the maiden's prayer,—but now that he's on his uppers for a time and has to buy time in a two-lunger light airplane to keep his license, they are starting to call him names. Read the following clipping from a Keokuk, Ia., paper, sent in by R.W.C., of Memphis, Mo.: "Piloting a passenger plane bids fair to become a sinecure. Experiments have been made with a robot pilot that keeps a huge eighteen-passenger airliner on its course after it is once in the air. The mechanical pilot will relieve the human wreck while they check the motor, operate the radio or take bearings."

We read that a new municipal field is under development in Zurich, Germany "to rid the military airport in the city of commercial activity." Over here it isn't any problem to rid a place of commercial aeronautical activity.

What Has Become of the Old Fashioned Trans-Atlantic Flight for Promoting Amity Between Nations?

"Budapest, Oct. 25 (New York *Times*)—Strenuous efforts have been made to persuade Capt. George Endres, the pilot, and Alexander Magyar, navigator, of the airplane 'Justice to Hungary,' which recently made a trans-Atlantic flight, to abandon their intention of fighting a duel over the division of the proceeds of the flight. The Hungarian Aviation Society pointed out to them the bad impression abroad. As a result of these efforts the duel will not take place. The American sausage manufacturer who financed the flight soon will return to the United States, with Herren Magyar, and Captain Endres remaining in Hungary."

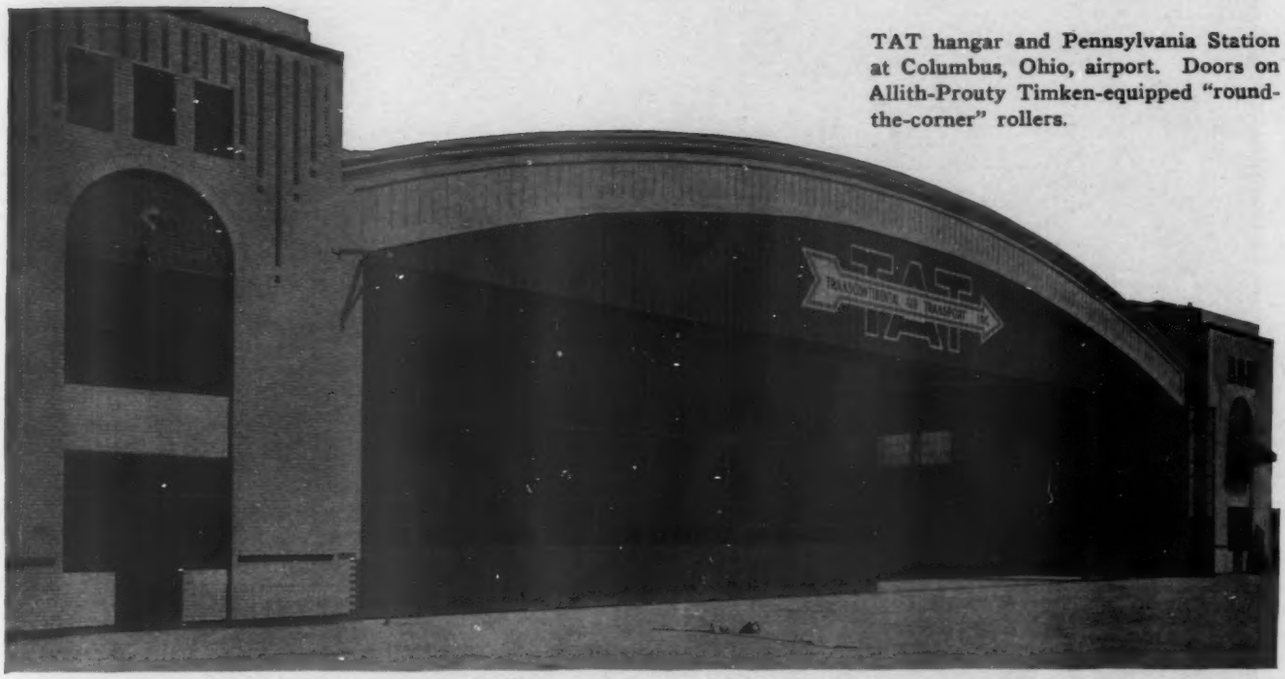
"Budapest, Hungary, Oct. 27 (AP)—Capt. Alexander Magyar, who with Maj. George Endres, made a non-stop flight from the United States to Budapest last July, and Gisela Puskas, former wife of George Santelli, New York fencing master, were married today."

"The newest X has a span of thirty-eight feet, five foot chord, length, eighteen feet, and weighs two hundred and eighteen pounds empty. Its grinding ratio is 18:1." Clipping from a contemporary aeronautical magazine by A.M., Jr., of Rochester, N. Y.

As noise in aircraft is one of the problems we have to solve we might as well have a coefficient for it. We suppose the ratio shows how much noise the average human being can stand compared with the amount produced by the aircraft.

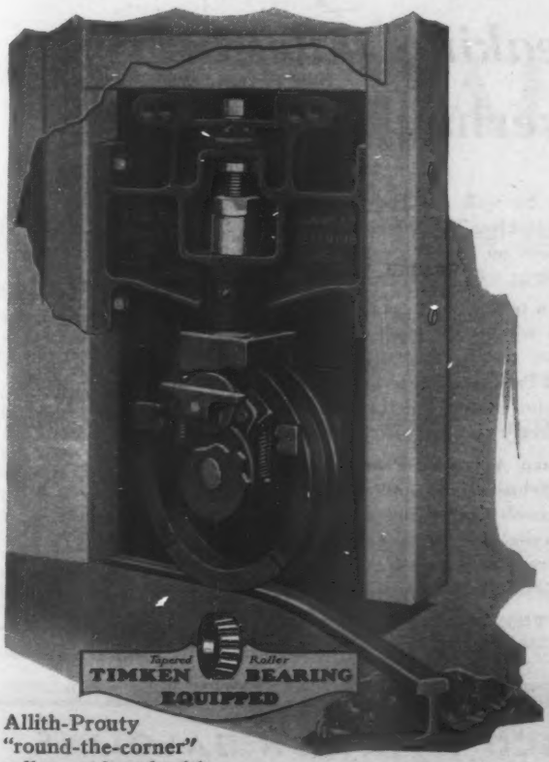
Our hangar flying department

EVERY industry is afflicted with a large number of haywire inventors, but it seems to us that aviation has had an unusually large crop of very pernicious inventors,—but this may be because we come in contact with them to a greater extent than with the inventors of other businesses. In our connections we have to interview a large number of these inventors and almost invariably we have great difficulty pointing out to them that their ideas are impractical, provided, of course, that the ideas are impractical. They almost always accuse us of being so accustomed to the "old, antiquated methods" of aeronautics that we can't recognize their amazing new conception which is going to make aviation safe for the multitude and save vast numbers of human lives each year. Like most inventors, they leave unconvinced of our sincerity and more convinced than ever that their contraptions will be the solution of our problems. The inventor is as hardy and as impossible to discourage as the weeds of the fields, but, of this group, we know of one who holds the championship so far as we are concerned. Years ago he came into the Curtiss plant at Garden City, Long Island, and was interviewed by "Bill" Miller, who is now assistant chief at B. J. Aircraft. Bill looked over the inventor's drawings very carefully,—the idea was for a helicopter which was supposed to obtain lift by means of centrifugal pumps discharging through jets. After about twenty minutes of study and questioning, Bill said, "I'm sorry, but your idea has no value. No lift could be generated by the device you have here,—in fact I am very sure it would give negative lift." The inventor was not the least discouraged. "Alright," he said, "I'll just turn the machine upside down and use it that way."



TAT hangar and Pennsylvania Station at Columbus, Ohio, airport. Doors on Allith-Prouty Timken-equipped "round-the-corner" rollers.

The doors roll on ALLITH-PROUTY rollers equipped with Timken Bearings



Allith-Prouty "round-the-corner" roller equipped with Timken Bearings on wheel and swivel.

Modern airport hangar doors roll swiftly, smoothly, effortlessly on Allith-Prouty Timken-equipped rollers manufactured by the Allith-Prouty Company, Danville, Ill.

Timkens are used in the track wheels and swivels of Allith-Prouty "round-the-corner" type rollers, and in the track wheels of the "straight slide" rollers.

They not only make these huge doors easy to operate by eliminating friction, but also add years to door equipment life by preventing wear on swivels and wheel axles. Lubrication is a negligible factor.

Specify Timken-equipped door rollers for your new hangars.

THE TIMKEN ROLLER BEARING CO., CANTON, O.

TIMKEN *Tapered Roller* BEARINGS

Capt. Frank M. Hawks

71,000 record-breaking miles without an overhaul

THE aviation industry will readily appreciate that the TEXACO 13 might be accurately termed a "flying laboratory."

Few planes, or motors, have been tested under such severe conditions. Continuously flying at unprecedented speeds on two continents, Captain Hawks has focused the attention of the world, lay and professional, on the advantages of speed. Those who know, realize the demands occasioned by over 71,000 miles of flying at such record-breaking speeds.

Texaco Lubricants and Texaco Aviation Gasoline, exclusively, were used on these flights. So well did they perform that even after 71,000 record-breaking miles no engine overhaul was necessary.

It is a tribute to Captain Hawks for his wonderful handling of the ship, to the high quality of the Texaco Products and to the Wright Whirlwind motor, which functioned so perfectly throughout the flights.

Texaco Aviation Products are used exclusively at foremost aviation schools and flying bases, and are available at principal airports throughout the country. Write The Texas Company.

THE TEXAS COMPANY
135 East 42nd Street, New York

EUROPEAN FLIGHTS

	Miles	Hrs.	Min.
Paris to London	218	—	59
London to Berlin	600	2	57
Stockholm to Malmo, Sweden	320	1	30
Malmo to Paris	700	3	15
Copenhagen to Amsterdam	460	2	30
Paris to Rome	700	3	30
Budapest to Rome	650	3	30
London to Rome*	950	4	44
Rome to London*	950	5	—
London to Dublin	320	1	40

*Same day

AMERICAN FLIGHTS

	Miles	Hrs.	Min.
New York to Los Angeles	2510	14	50
Chicago to New York	750	3	20
Detroit to New York	640	2	41
Boston to New York	210	—	52
Philadelphia to New York	90	—	20
New York to Havana*	1403	8	8
Havana to New York*	1403	7	30
Montreal to New York	350	1	45
Edmonton to Calgary	179	—	50

*Same day

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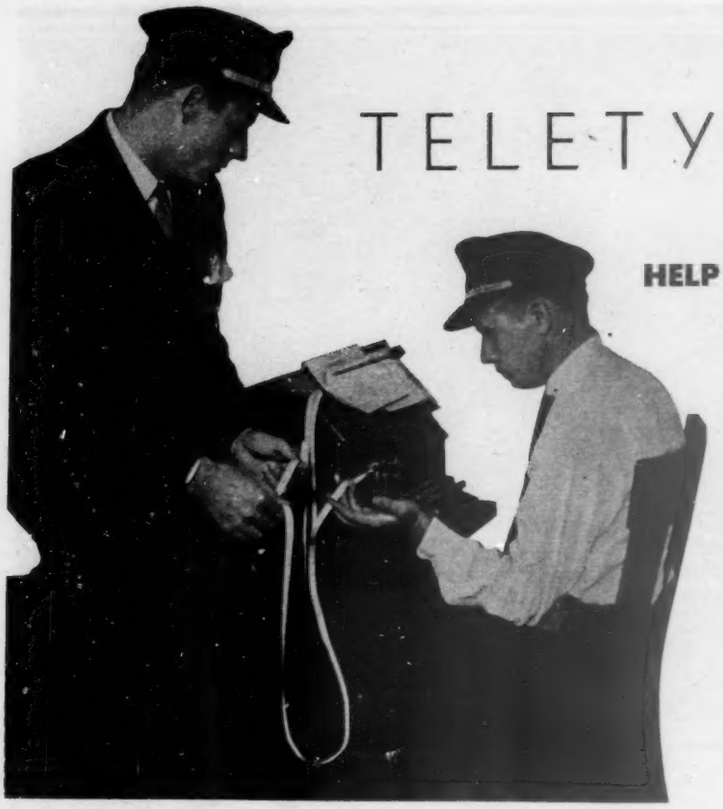
TEXACO AIRPLANE OILS • TEXACO AVIATION GASOLINE
TEXACO AERODIESEL FUEL • TEXACO MARFAK GREASES
TEXACO ASPHALT PRODUCTS FOR RUNWAYS, HANGAR FLOORS AND APRONS, AND DUST LAYING

Things are happening *at* BALTIMORE

HERE, at the great Curtiss-Caproni plant in Baltimore, the General Aviation Manufacturing Corporation *(formerly Fokker Aircraft Corporation)* has now concentrated all its activities, administrative and manufacturing.

Here, where increased facilities permit important manufacturing economies, new and finer types of ships are being developed with the aid of the vast technical resources of the General Motors Research Division — ships incorporating new engineering features which will make General Aviation products still more exceptional in those qualities of dependability, performance and long life for which they have always been noted

GENERAL AVIATION MANUFACTURING CORPORATION
Division of General Aviation Corporation
P. O. Address: Dundalk, Baltimore, Maryland
New York Sales Office: 1775 Broadway



TELETYPEWRITERS

HELP PENNSYLVANIA AIRLINES, INC., SUPPLY FAST MAIL AND PASSENGER SERVICE BETWEEN CLEVELAND AND WASHINGTON

PENNSYLVANIA AIRLINES, Inc., provides fast, luxurious air travel between Cleveland, Akron, Pittsburgh and Washington . . . furnishing direct connections with other lines serving principal cities on this continent. Many of the passengers are business men to whom punctuality is of prime importance. Teletypewriters* insure the speedy, accurate and flexible communication essential in maintaining this service.

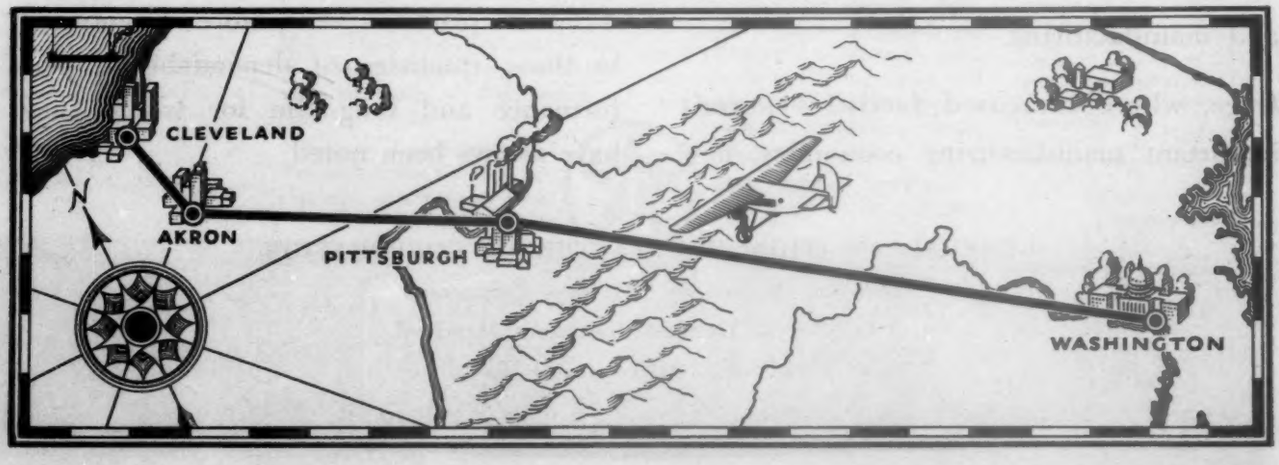
"Teletypewriters play a vital part in our operations," says H. S. Martin, president. "For instance, Pennsylvania Airlines makes twenty connections a day, necessitating a large number of through reservations over other airlines. Without Teletypewriter Service, it would be almost impossible to handle them efficiently.

"We also get instant advices over this modern communication system as to the quantity of mail and its destination, arrivals and departures of our airplanes, weather reports, administrative matters, dispatches, and a host of other items essential to efficient service."

Teletypewriter Service—typing by wire—is used by many other transport companies, and by airplane manufacturers. It forms the veritable *nerve center* of an organization, keeping widely separated units in constant and instantaneous "written conversation" with each other. Your local Bell Telephone Company will gladly give you full information about this modern business aid. Just call the Business Office.

★ ★ ★

**Teletypewriters are connected by Bell System wires in such a way that a message typed on one machine is instantly reproduced in identical typewritten form on any or all connected machines. They can be operated by any one who can operate a typewriter. As many as 60 words a minute can be sent and received.*



FAMOUS FLIGHTS WITH THOMPSON VALVES

CROSS COUNTRY AT 218 MILES AN HOUR

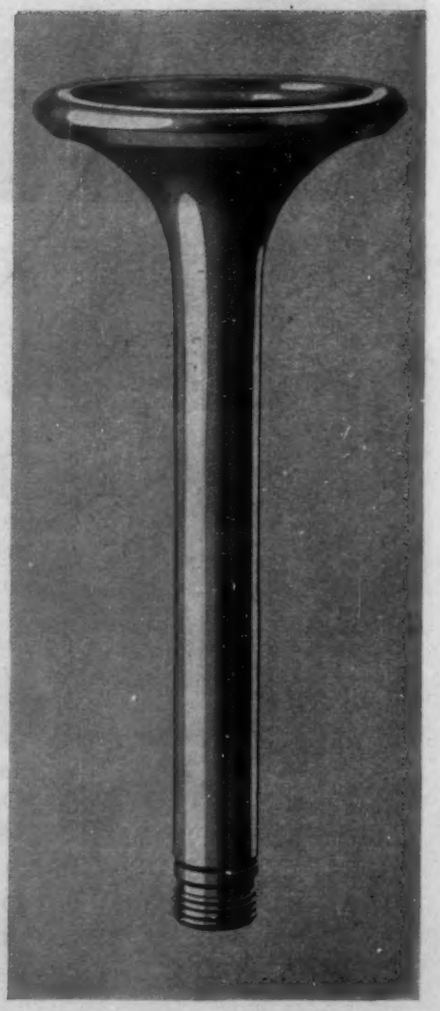
This advertisement is one of a series recalling historic airplane flights in which Thompson Valves were used.

. . . *to a new Coast-to-Coast Record*

Thousands stood and cheered as Major "Jimmy" Doolittle set his oil-streaked Laird Solution down at Cleveland Airport on September 4th — winner of the first Bendix Trophy Race. From dawn at Burbank, California, to early afternoon — and the finish line — Doolittle had set a terrific pace in his bullet-like ship . . . 9 hours and ten minutes of breathless speed!

Then, stopping only to refuel, he was off again — for Newark, N. J., and Captain Hawks' coast-to-coast record. Less than 10 minutes after winning the Bendix Race, Doolittle's plane was a rapidly disappearing speck over Cleveland. When Newark saw him, the new transcontinental flight record was a fact — 2,450 air miles in 11 hours and 16 minutes — over 218 miles an hour!

Throughout the gruelling flight, the performance of Doolittle's Wasp Junior motor had been faultless. Thompson Valves, on which much of that performance depended, had again aided in an outstanding aeronautic achievement!



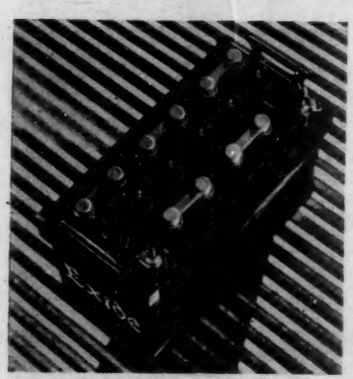
THOMPSON PRODUCTS, INCORPORATED

General Offices: Cleveland, Ohio, U. S. A.
Factories: CLEVELAND and DETROIT

Thompson Valves

THE ELECTROLYTE WILL NOT SPILL

You may look at Chicago like this and yet be battery-safe, when there's an Exide in your cockpit.



This Exide Aircraft Battery was made to fly. It's light-weight, compact, safe.

Contractors
to the U. S. Army & Navy

Exide Aircraft Batteries are so designed that even loops will not spill the electrolyte

THE Exide Battery is as dependable as it is safe. It helps make radio communication certain in fog and storm. It furnishes reliable current for landing, navigation and instrument lights—starting and ignition.

Exides have already proved their worth over millions of miles of sky lanes. Just ask your flying friends about Exide reliability . . . its compactness . . . its light weight.

Write today for further information about the many types of Exide Aircraft Batteries. One-seater "mono" or transcontinental air liner—there's an Exide to fill the bill.

Exide
AIRCRAFT
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
THE WORLD'S LARGEST MANUFACTURERS OF STORAGE BATTERIES FOR EVERY PURPOSE
Exide Batteries of Canada, Limited, Toronto

United Air Lines Fly 35,000,000 Miles with STROMBERG Carburetors

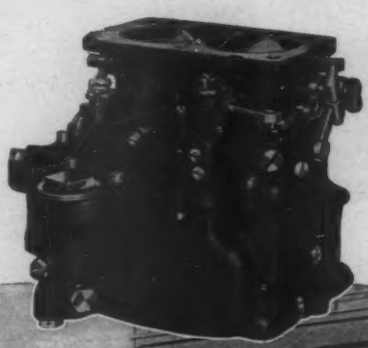
UNITED Air Lines is the largest air system in the world. They recently completed 35,000,000 miles of commercial flying; 15,000,000 of them at night. The latter figure represents five times as much night flying as in all the nations of Europe combined.

The United fleet is powered by Wasp and Hornet engines, each one equipped with a Stromberg Carburetor. You'd expect it—only the best can stand United Air Line operating conditions; from sea level to 12,000 feet; and at temperatures ranging from 40° below to 120° above.

Stromberg Carburetors are standard equipment on 95% of all the planes flying in the United States today.

Reasons: Easier starting, smoother idling, more economical; at all speeds, more power.

Stromberg engineers with 22 years carburetion experience will gladly cooperate in working out your carburetion problems.



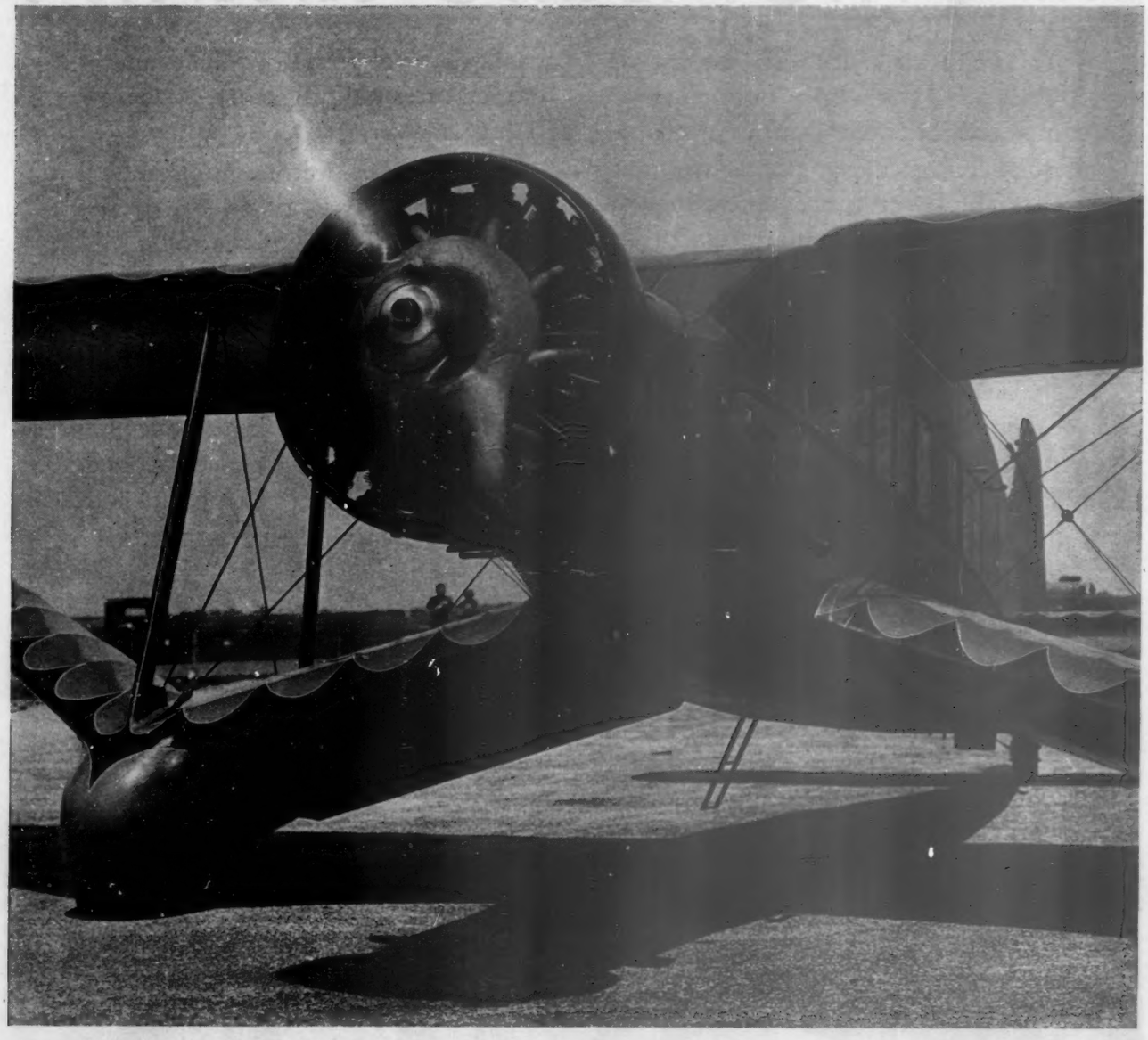
STROMBERG CARBURETORS

BENDIX STROMBERG CARBURETOR COMPANY

«SUBSIDIARY OF BENDIX AVIATION CORPORATION»

701 BENDIX DRIVE - SOUTH BEND, INDIANA

"Warm 'er Up"



EVEN in the coldest weather . . . Socony De-Waxed Motor Oil delivers instant lubrication and cuts down the warming-up time. Because it is wax free, this oil always flows readily, and your oil gauge quickly shows the right oil temperature for correct engine lubrication.

Fueled with Socony Aviation Gasoline and lubricated with Socony De-Waxed Motor Oil, your engine will give as many r.p.m.'s as it was built to deliver. Try this combination.

SOCONY

AVIATION GASOLINE · DE-WAXED MOTOR OIL

STANDARD OIL COMPANY OF NEW YORK

Your choice of a school decides your future

CHOOSING A SCHOOL is the first important step in your career in aviation—the judgment you use will be an indication of the judgment you will be *expected* to use as a pilot or mechanic.

The world's largest operators of air-mail and transport lines, combined with the largest aggregation of manufacturers of planes, engines and equipment, are the companies to whom student pilots and mechanics naturally look forward as furnishing their greatest opportunities for placement in aviation work.

And these companies are vitally interested in developing the highest type of aviation *training*. United Air Lines, Pratt & Whitney, the Boeing Companies, Chance Vought, Stearman, Hamilton, Sikorsky—all these are part of the same organization that owns and operates Boeing School of Aeronautics.

Boeing graduates are not, of course, guaranteed or assured employment. But America's largest employers of pilots and trained mechanics, knowing Boeing School standards, look to Boeing School first . . . Catalog of courses, with entrance requirements, cost, full description of facilities, etc., will be mailed on request.

BOEING

SCHOOL OF AERONAUTICS

Subsidiary of United Aircraft & Transport Corp.

BOEING SCHOOL OF AERONAUTICS
Room 12-C, Airport, Oakland, California

Gentlemen: I am interested in

- ☐ Private Pilot
- ☐ Limited Commercial Pilot
- ☐ Transport Pilot
- ☐ Boeing Master Pilot
- ☐ Boeing Master Mechanic
- ☐ Special Master Pilot (For Transport Pilots)

Name_____ Age_____

Address_____

City_____ State_____

CORSAIRS

that wear the GLOBE AND ANCHOR *of the U. S. Marines*

Corsairs **in service with the Marine Corps are usually in *active* service. It may be in Haiti, whose ragged, mountainous interior affords few landing fields that are even possible. It may be over the inaccessible jungles of Central America. It may be in China in sections where plane failure would write "Finis" to an aerial mission.**

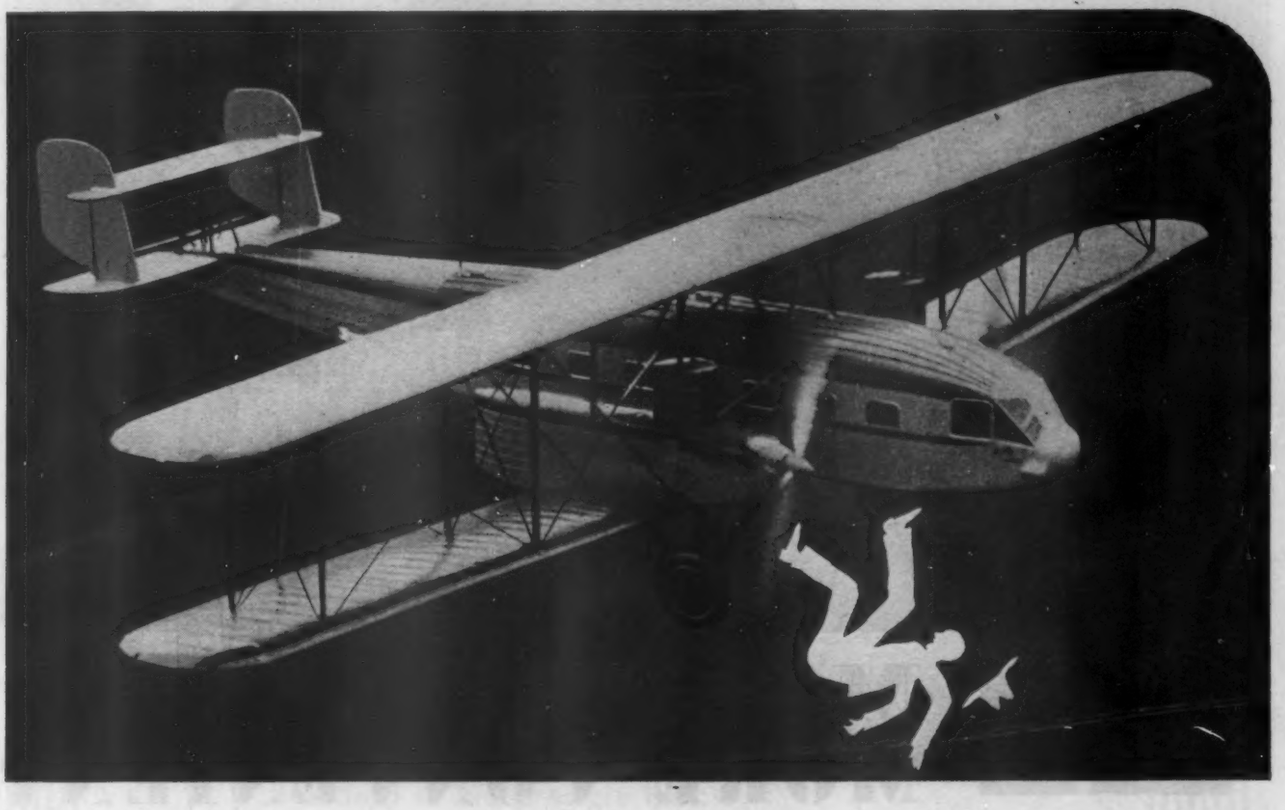
Corsairs **ask no odds of the men who make their assignments, or the men who do the flying. The stamina to stand rough landings and the performance to get into and out of small fields are traditional with this plane. So, too, are its speed—its climb and its excellent handling qualities.**

These distinctly Vought characteristics have carried *Corsairs* through years of strenuous service with the Marine Corps. They have made the *Corsair* a standard observation plane with the Navy. And they make it an ideal ship for fast executive transport and private flying. Chance Vought Corporation. Division of United Aircraft & Transport Corporation, East Hartford, Connecticut. Export representative: United Aircraft Exports, Inc., 230 Park Avenue, New York, N. Y.

CHANCE VOUGHT CORPORATION

AND DON'T TRY COMING UP AGAIN, MR. WATER-THIN

YOU'RE NOT WANTED IN THIS PLANE!



EVERY HOUR of flying costs more when Mr. Water-thin is in a plane. For he's the quart or more of thin, waste oil that ordinary refining leaves in every gallon of aero oil. It can't prevent wear because it can't lubricate. It increases oil costs because it vaporizes quickly under motor heat.

But there's none of this stuff in Quaker State Aero Oil. For Quaker State employs *the most modern refining in the industry* to throw it out. And Quaker State replaces it with rich, full-bodied lubricant. Quaker State gives you four full quarts of lubricant to the gallon, not three quarts and one of useless waste. So you really get an extra quart of lubricant. That's why Quaker State is to-day the *world's largest selling Pennsylvania Oil.*

Better, more modern refining isn't the only reason why Quaker State is the finest oil you can put into a plane. Quaker State's start in life has a lot to do with its quality. For every drop of Quaker State is made entirely from 100% pure Pennsylvania Grade Crude Oil. It is so free from impurities that it doesn't have to be treated with acids in refining. That's important to remember! For acids tend to destroy some of an oil's oiliness.

Let impartial tests in your own planes prove to you that Quaker State can save you money every hour those planes fly. It won't take you long to discover that Quaker State means lower oil costs because it lubricates for far more hours. And that it cuts maintenance costs because it ends repairs due to oil failure. If you leave it up to the cost sheet, you'll be using Quaker State Aero Oil!

QUAKER STATE
TRADE-MARKS REG. U.S. PAT. OFF.
MOTOR OIL

THERE'S AN **EXTRA QUART**
OF LUBRICATION IN EVERY GALLON

GIVE YOUR PASSENGERS POSTAL TELEGRAPH SERVICE *EN ROUTE!*

MAKE AIR TRAVEL MORE CONVENIENT

As long as people travel they'll want to send messages en route...messages of greeting...reservations and appointments...all kinds of messages. They're accustomed to being in constant touch with the world while traveling on land or sea. And it's to the operator's advantage to offer them the *convenience* of communication facilities aboard the plane.

Air transportation companies can now make every plane a definite part of a world-wide system of communications.

The traveler merely secures a Postal Telegraph blank from a rack conveniently located in the cabin, writes his message and hands it to the attendant for filing at the next airport. Postal Telegraph does the rest. No fuss...no bother ...no delay.

Extra convenience for air travelers at absolutely no expense to the air transportation company.

Wire Postal Telegraph Headquarters at New York City *collect* for more details.

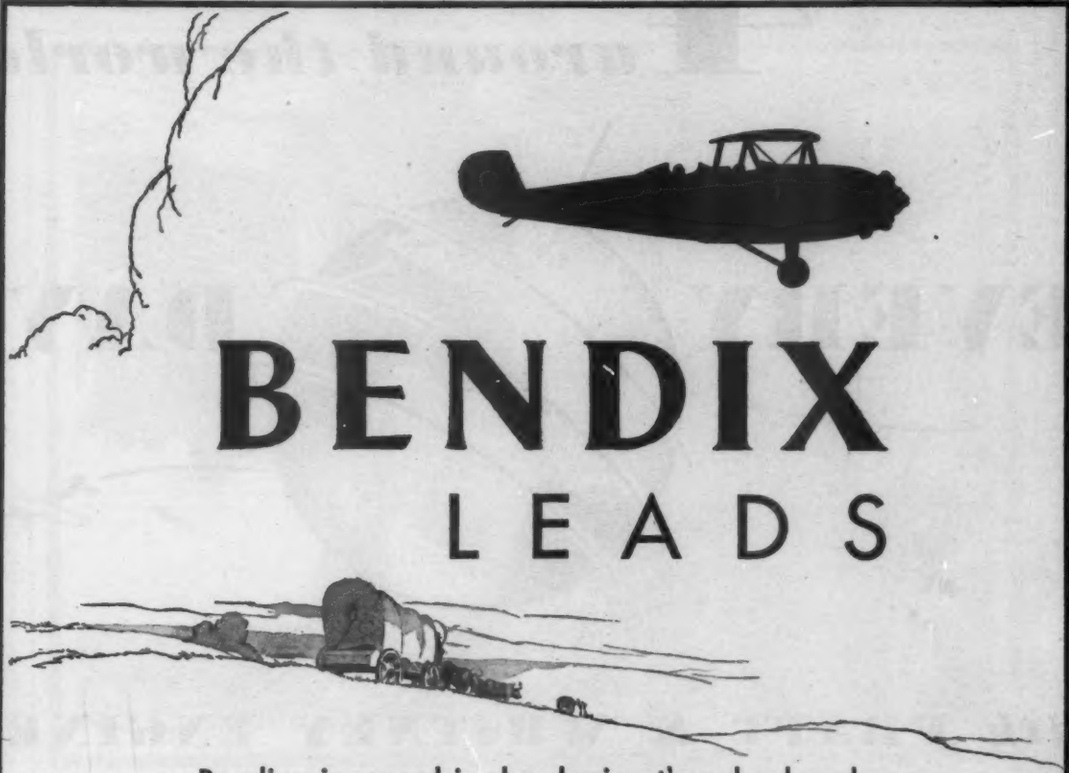
Postal Telegraph is the only American telegraph company that offers a world-wide service of coordinated record communications under a single management. Through the great International System of which Postal Telegraph is a part, it reaches Europe, Asia, The Orient over Commercial Cables, Central America, South America and the West Indies over All America Cables, and ships at sea via Mackay Radio.

THE INTERNATIONAL SYSTEM

Postal Telegraph

Commercial Cables — *All America Cables*

Mackay Radio



BENDIX
LEADS

Bendix pioneered in developing the wheel-and-brake for aircraft.

Bendix first provided roller-bearing wheels for standard or low pressure tires.

Bendix' scientific facilities persist in endless research for that which is better—for that which will simplify ground maneuvering of planes, and increase safety.

Consistently Bendix leads—in rugged dependability of product, in adoption of proved improvements.

BENDIX BRAKE COMPANY
SOUTH BEND, INDIANA
(Subsidiary of Bendix Aviation Corporation)

BENDIX FOR AIRPLANE WHEELS *and* SAFETY **BRAKES**

FULLY PROTECTED BY PATENTS AND APPLICATIONS IN U. S. AND ABROAD

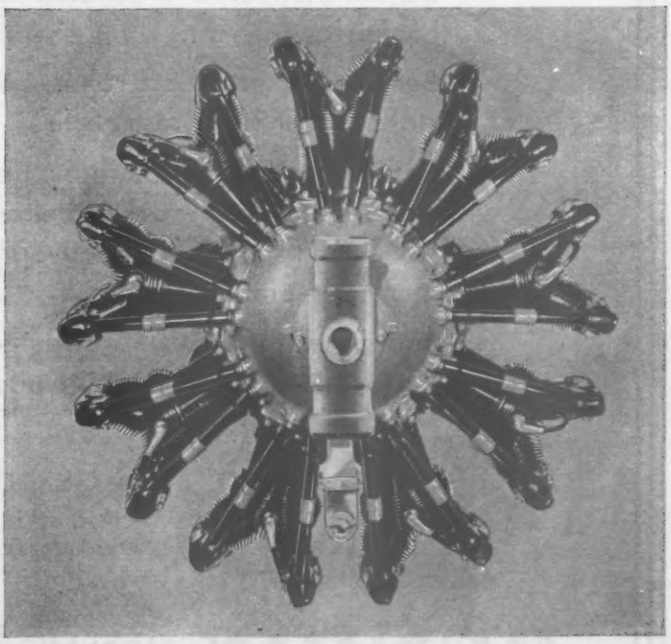
Air Mail Saves Time

4 *times around the world*

EVERY DAY

with PRATT & WHITNEY ENGINES

With every tick of the clock Pratt & Whitney engines are making new entries in their records of dependability. During every hour of every day private, military and commercial planes are completing flights which owe their speed and performance to superb power. On government regulated air transport routes alone, Wasps and Hornets average, at a conservative estimate, over 100,000 miles daily. Here is a never ending test of stamina—a continuous check upon the choice of Pratt & Whitney power plant equipment by America's major air transport lines.



THE
PRATT & WHITNEY AIRCRAFT CO.
EAST HARTFORD . . . CONNECTICUT, U. S. A.
Division of United Aircraft & Transport Corporation

Manufactured in Canada by Canadian Pratt & Whitney Aircraft Co., Ltd., Longueuil, Quebec; in Continental Europe by Bavarian Motor Works, Munich; and in Japan by Nakajima Aircraft Works, Tokyo.

Wasp* & Hornet*

*REGISTERED TRADE-MARK

Engines

More R.P.M. with PENNZOIL *for winter costs less per hour*

Poor oil cuts down your speed in winter. It congeals at starting and binds your motor. It thins out after the motor gets warm and fails to lubricate properly. To be safe—put Pennzoil in your motor this winter. It lubricates in high and low temperatures alike. It doesn't break down after a few hours' flying. It lasts twice as long as ordinary oils and costs less per hour. For speed, for economy—use Pennzoil for winter. You'll like it.

Ask for PENNZOIL—
Not just "Pennsylvania Oil"

The PENNZOIL COMPANY: Executive Offices and Refinery: Oil City, Pa.
Division Offices: New York, Chicago, Los Angeles
British-American Oil Co., Ltd., Sole Distributors in Ontario and Quebec, Canada

100% PURE PENNSYLVANIA
PENNZOIL
SAFE LUBRICATION

PENNZOIL is made by the famous Pennzoil Process from 100% pure Pennsylvania crude and nothing else.

PERMIT NO. 2—PENNSYLVANIA GRADE CRUDE OIL ASS'N

B G

MICA AVIATION SPARK PLUGS

(Patented in the United States and Other Countries)

Considered from the only standpoint that is really important, that of superior and uniform service, B. G. Mica Aviation Spark Plugs are *highest* in flying safety and *lowest* in service cost. They are made of the best materials throughout, insulated with selected mica which is the only insulating material that will withstand mechanical abuse and meet all the demands of modern aviation engines. They are wrought by specialists, every one of whom is a craftsman at his particular bench. Severe testing and meticulous inspection prove the high uniform quality of every plug. Unremitting efforts to improve an already *good* product—constant striving to make a *better* plug—have resulted in the unquestioned leadership of B. G. throughout the entire aviation industry.

B. G. Radio Shielded Spark Plugs Eliminate Ignition Interference

The B. G. radio shielded spark plug—in conjunction with shielded magnetos and harness—eliminates all ignition interference, keeps out dirt, water and oil and gives positive contact. It is insulated with mica—the superior insulating material. It has standard shell and core hexes, is easily serviced with standard B. G. tools, and can be assembled to harness without solder. Terminal connections fit any make of shielded harness, and are interchangeable on all B. G. radio shielded plugs. The threaded elbow terminal prevents short-bend wear and tear on harness and provides quick accessibility. Made in types for super-charged and super-compressed engines to meet idling or full throttle conditions.

THE B. G. CORPORATION

Contractors to the United States Army and Navy and Aircraft Engine Builders

136 West 52nd Street, New York **Cable Address: Golsteco, New York**

BIRD 3-place, 100 hp.

. . Kinner Engine, *fully equipped* Now $2995 . . . . a direct saving of nearly $1000

MANY engineering refinements and items of approved modern equipment have been added to Bird planes during recent months . . . . improvements that assure even better performance, greater safety and lower maintenance costs. *Exceptional beauty* of line and finish contribute to your pride of ownership.

These improvements plus low first cost, make the 3-place 100 hp. Kinner-Bird, the ideal plane for flying clubs and private owners, in the opinion of experienced pilots.

Note the items comprising standard equipment. Write the factory to put you in touch with the nearest Bird representative. *A demonstration will convince you of Bird superiority.*

BIRD AIRCRAFT CORPORATION
Glendale, L. I. **New York**

BIRD

THE SAFE AIRPLANE

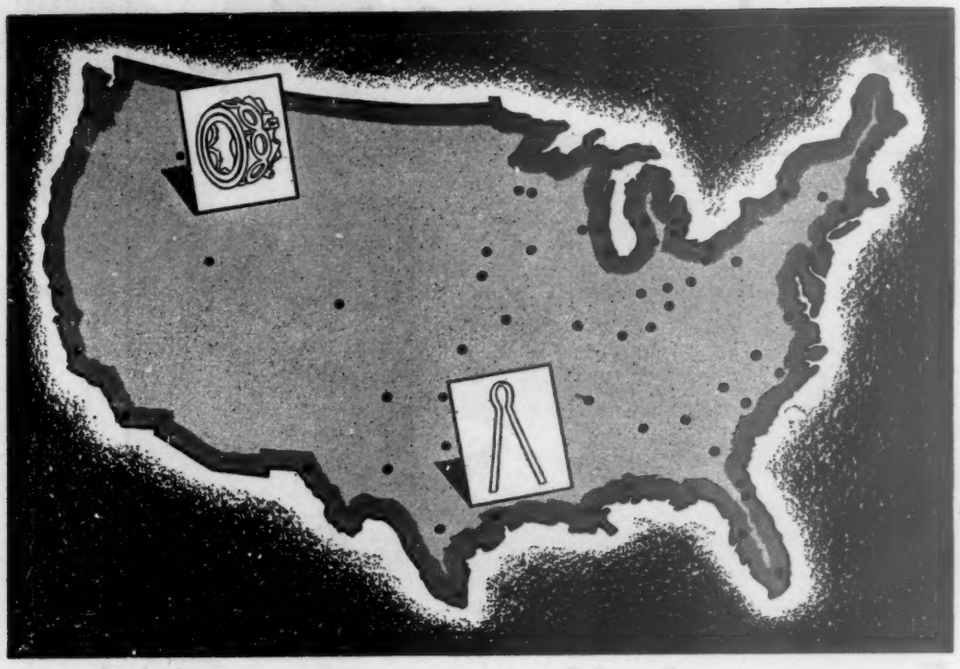
Standard Equipment

Instruments including compass
Semi-air wheels and brakes
Combination oleo-rubber struts
Dual controls
Navigation lights
Cockpit cover
Wood propeller
Collector ring

This plane covered by the famous BIRD CHALLENGE

Nearly $1000 less in price but not one cent less in quality or performance. Like all BIRD planes, the 3 place, 100-hp. Kinner BIRD at $2995 invites comparison under the famous BIRD Challenge.

Bird planes invite comparison in performance with any others in their power range — including planes equipped with rotor vanes, slots, flaps or variable camber wings.

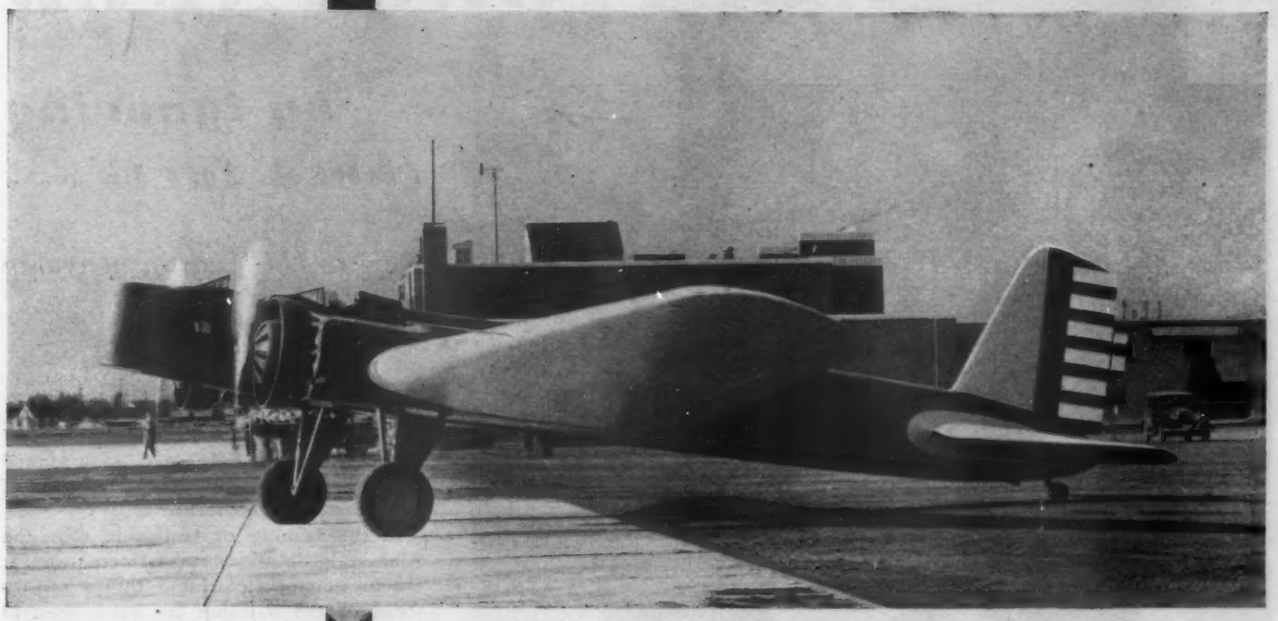


. . . build around *Wright Engines* and the 88 Wright Service Stations with everything available from a crankcase to a cotter pin

Wright provides the only extensive Nation-wide service for aviation engines. Thus, Wright Engines are a matchless combination of brilliant performance and complete service. ◉ At 88 Wright Service Stations skilled mechanics are on hand to keep Wright Engines up to the high standards of power production put into them by their designers and builders. Adequate stocks of spare parts are carried at each station. Prices are uniform. High standards of service are maintained on the same sure quality level as at the Wright factory. ◉ Keen builders of planes use Wright reliability and particularly Wright Nation-wide Service as sales advantages. World records for speed, distance and endurance are an infallible precedent for the use of Wright Engines in any plane. And Wright places its engineering skill and experience at the disposal of builders of planes.

WRIGHT
AERONAUTICAL CORPORATION
PATERSON NEW JERSEY
A DIVISION OF CURTISS-WRIGHT CORPORATION

BOEING
builds a bomber!



When a manufacturer of world-famous military pursuit planes decides to build a bomber, you naturally expect a departure from the ordinary. . . . Boeing engineers have, indeed, developed a bombing plane of radically new type. Designed to carry a crew of five and bombs weighing more than a ton, this twin-motored, all-metal monoplane takes off, retracts its landing gear and *decidedly out-performs any other large bomber ever built!*

Boeing Airplane Company, Seattle, Subsidiary of United Aircraft and Transport Corporation.

...DON'T GET GROUNDED

by ignoring these facts...

Here are big reasons why one aviation oil "outflies" all others!!

Flying hours are what count... and one oil —Gulfpride—has been specifically refined to insure the greatest possible number of air hours between overhauls.

In the refining of Gulfpride Oils, the Aluminum Chloride process is followed. It employs material costing $100 per ton instead of the $10 per ton acids used in refining many other oils.

You can see the difference in performance in every way... in more air hours and in a cleaner, sweeter running motor.

Low carbon formation is the answer here. Gulfpride Oils show less than one-fifth as much carbon residue by Conradson test as the next best Paraffin Base Oil of comparable viscosity on the market.

Ask for Gulfpride Oil. If you appreciate the best in lubricants, you'll recognize it in this oil.

Get Useful Book of Air Facts

30,000 copies of the first edition Aviation Atlas have been distributed. Now the new edition is ready. Maps, Airways, Fields, Records. Everything you want. Free to licensed pilots, licensed mechanics, students in recognized flying schools and those associated with the Aviation Industry. Just drop a post card to Lubricating Department. See address below. We'll send you your copy at once.

MORE AIR HOURS

Gulfpride Oil is 100% paraffin base mineral oil refined by the costly Aluminum Chloride method. Exclusive to Gulfpride. Gulfpride Oil exhibits a relatively flat viscosity-temperature curve; high flash and fire values, and low pour tests.

Gulfpride Oil holds its body at high temperatures and resists breaking down under motor heat. It is highly resistant to oxidation and emulsifying action.

Gulfpride Oil is made in five viscosities: 75—100—120—150 and 200 at 210° F, providing a superior lubricant for all types of aircraft motors, under all operating conditions.

Ask for Gulfpride Oil and you'll never be grounded because of oil-caused trouble.

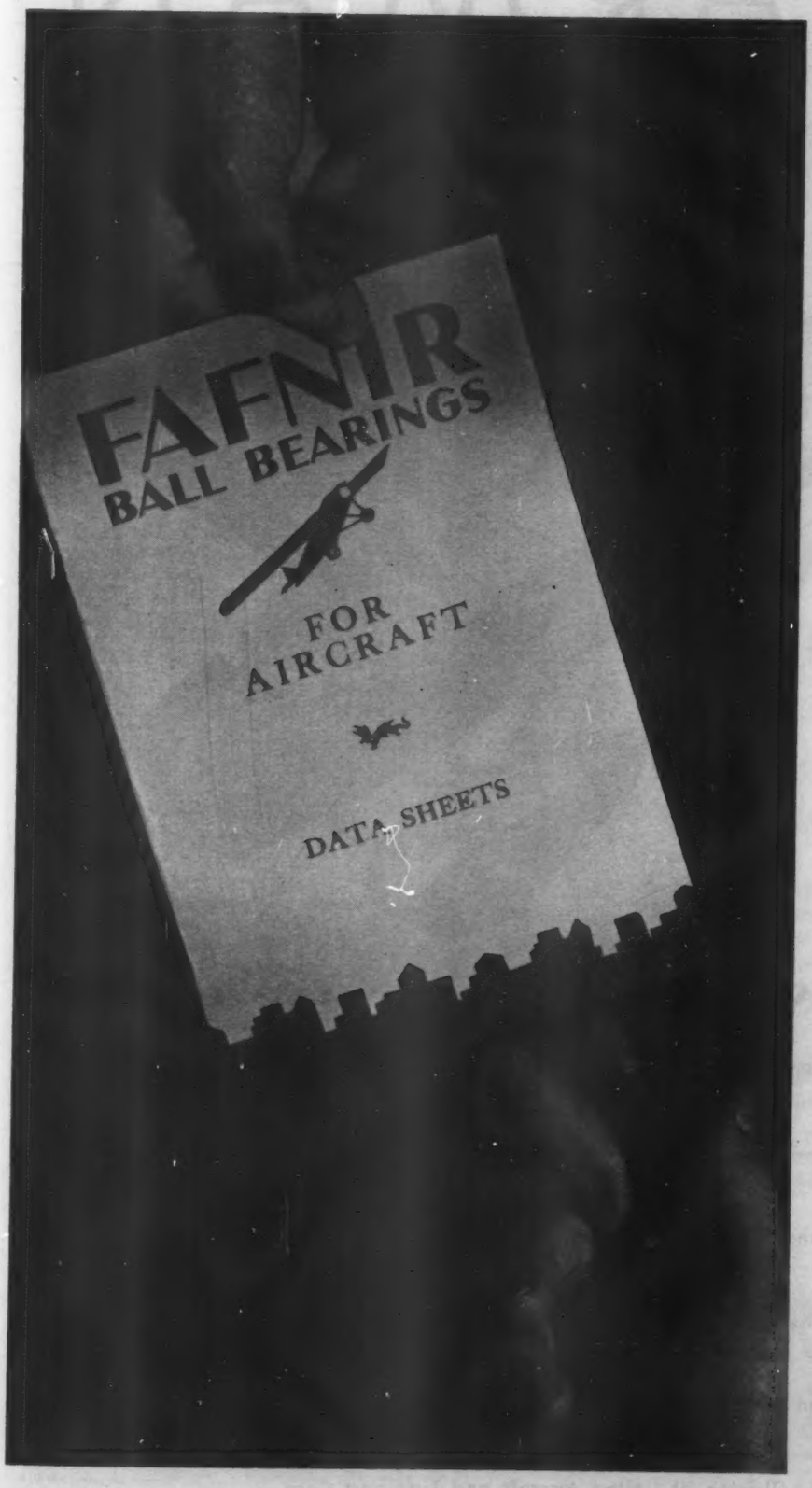
Gulfpride Oil

GULF REFINING COMPANY
General Sales Offices, Pittsburgh, Pa., U.S.A.

GULF

•GULF REFINING COMPANY•

Here's the Bearing Data you need



DIMENSIONS, weights and load capacities of every type of ball bearing required for aircraft control are contained in this volume. Descriptions of the bearing characteristics are comprehensive and so is the outline of recommended uses, all of which have been proven in actual service on many of the world's leading makes of planes.

That these Fafnir Ball Bearings should quickly gain such wide use is readily understood when the method of design is explained. Aviation engineers laid down the service specifications. Fafnir engineers produced the designs that satisfied every requirement—corrosion resistance and special seals for exposed applications; the ball bearing cartridge to simplify mounting design; the inch dimension series for convenience in layouts; narrow width types to save space and weight—all typical features of a specially designed line of bearings.

Every aviation engineer and designer will find the Fafnir Aircraft Data Sheets of assistance in improving design and promoting safety. Write for a copy. It is free and so is the cooperation of our engineers.

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NEW BRITAIN, CONN.

Atlanta Chicago Cincinnati Cleveland
Dallas Detroit Los Angeles Milwaukee
Newark New York Philadelphia

Safeguarding quality

FAFNIR
BALL BEARINGS

Another Distinguished Owner for STEARMAN

Powered by PRATT AND WHITNEY WASP JUNIOR

..ow, Texaco chooses Stearman . . . Richfield Oil, Standard Oil of Louisiana, Standard Oil of California and Shell — already fly Stearmans. Well known mail and express operators, too, have been flying Stearmans for years. Many prominent sportsmen are on the Stearman "roster." Outstanding values have led to these choices . . . Choose Stearman for every flying reason . . . the ship itself . . . the Stearman organization backed by United . . . the new factory, hub of nation-wide service facilities. STEARMAN AIRCRAFT COMPANY, WICHITA, KANSAS, Division of United Aircraft and Transport Corp.

Junior Speedmail 300 and 400 H. P.
. . . . . Business Speedster 240 H. P.
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PLANE-SPEAKER CORPORATION

Manufacturers of the

"VOICE OF THE SKY" EQUIPMENT

•

AN ANNOUNCEMENT AND A WARNING

THE PLANE-SPEAKER CORPORATION calls attention to the fact that it owns several United States Patents relating to the art of communication or broadcasting sound from aircraft while in flight, together with patent applications pending covering inventions which contain allowed claims for these devices. The United States patents which it owns are as follows: 1,581,586; 1,628,230; 1,667,287 and 1,667,300. It likewise owns patents in five foreign countries.

THE PLANE-SPEAKER CORPORATION is the pioneer in the field of broadcasting sound from aircraft. It has spent large sums of money over a period of years in developing and perfecting devices for such use. Accordingly, it proposes to vigorously enforce its rights under these issued patents, and under the patents which will issue on the applications which are now pending.

Aeronautical companies and individuals of high standing are invited to communicate with us regarding license to operate the Voice of the Sky equipment in definite territories.

Two sizes of equipment are manufactured for use respectively in single-motored and multi-motored cabin aircraft. Equipment for single-motored planes is portable and easily demountable and may be used as an airport public address system.

Operating Plane-Speaker equipment as an advertising medium, the Voice of the Sky, Inc. successfully completed advertising contracts for national advertisers aggregating one-half million dollars, covering 700 cities in the United States.

The equipment is readily adaptable for forest fire patrol and political campaigns. It is a dependable means of communication in time of emergency, such as floods, insurrections, earthquake, and for broadcasting police warnings, civic events, etc.

Licenses are in force in the following states: North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee and New Jersey.

The following organizations are authorized under the patents of the Plane-Speaker Corporation, and then only with apparatus furnished by this corporation: United States—General Flyers Aerial Broadcasting Company and the Roosevelt Aerial Advertising Service. Foreign—The British Air Ministry, and the Voice of the Sky, S. A., Milano, Italy.

Voice of the Sky broadcasting equipment is the most powerful in the world. Its message is heard by those on the ground both indoors and outdoors within a wide radius.

THE PLANE-SPEAKER CORP.
227 EAST 45TH STREET, NEW YORK CITY
CHARLES L. LAWRANCE, President

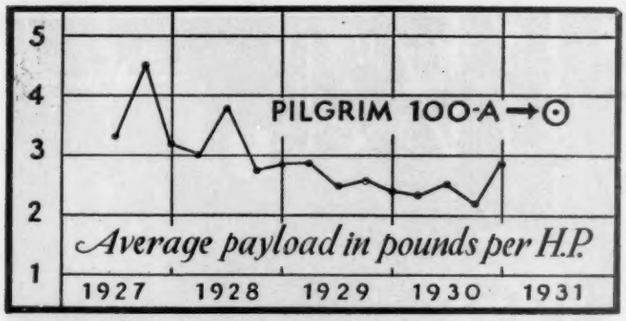
MAINTAINING THE HIGH STANDARDS *of the Industry*

Hundreds of individual operations are performed daily in a shop such as ours. Some of these in themselves seem an insignificant part of the total necessary in the construction of an airplane engine—but each one individually assumes mighty importance, for one imperfection or a single carelessly performed operation has many a time spelled disaster. Aviation has no place for imperfections, that is why engine manufacturers, whose strongest desire is to build a product as near mechanical perfection as possible, have come to Govro-Nelson for machinings and assistance in design.

Here, they realize, they may depend upon the finest equipment and skilled engineers whose watchword is precision. Send your blue prints or problems for advice and quotations.

THE GOVRO-NELSON COMPANY
1931 ANTOINETTE DETROIT

CRAFTSMEN TO THE AVIATION INDUSTRY



Data from Aeronautics Bulletin No. 21 of U. S. Department of Commerce, covering all approved types of airplanes.

PAYLOAD means INCOME
HORSEPOWER means EXPENSE

MODERN AIR TRANSPORTATION requires every facility for comfort of passengers. Large cargo space for mail and baggage, and full equipment of the most modern aids to navigation, including complete two-way radio telephone and night flying equipment.

Maximum PAYload per Horsepower Means PROFIT

PROFITABLE AIR TRANSPORTATION requires the moving of LARGE REVENUE PRODUCING LOADS swiftly from place to place, with a REASONABLE EXPENDITURE OF POWER.

The 10 PLACE
PILGRIM 100-A
TRANSPORT AIRPLANE

carries, in addition to this complete equipment, a PAYLOAD of 2140 pounds at 2 miles a minute with a single engine of 575 H.P., and provides a cabin for 9 passengers in comfort, a toilet compartment and 72 cubic feet of additional space for mail and baggage. That's why we say: "Developed to suit today's transportation needs—not designers' prejudice".

AMERICAN AIRPLANE & ENGINE CORPORATION

Manufacturing Division of The Aviation Corporation, Farmingdale, L. I., N. Y.

Manufacturers of PILGRIM Airplanes and RANGER Engines.

Where there is no landing there must be no failure

For SPRINGS of any kind, of any material, for any purpose in motor, controls or landing gear, use

GIBSON-SPRINGS

WM. D. GIBSON CO.

1800 Clybourn Avenue • • • CHICAGO, ILL.

Send for our Catalogue

FLEETWINGS
INCORPORATED

SPECIALISTS IN SPOT WELDING STAINLESS STEEL

Three years! development in spot welding of stainless steel enables us to offer the aviation industry the benefit of our experience.

Spot welded stainless steel construction offers definite advantages compared to wooden, aluminum alloy, or torch welded steel structures. It eliminates all possibility of corrosion, even from salt water. Tests have demonstrated that spot welded stainless steel has remarkable resistance to fatigue.

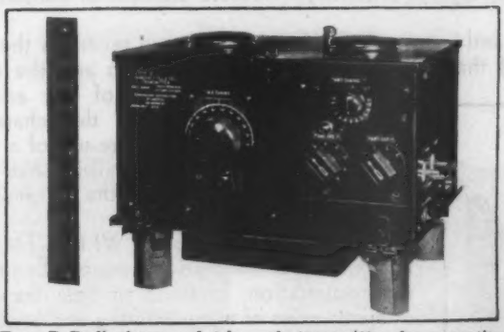
Manufacturers alert to modern trends in aircraft design should investigate our experience and facilities for engineering and fabricating spot welded stainless steel structures to meet government requirements.

Write for particulars.

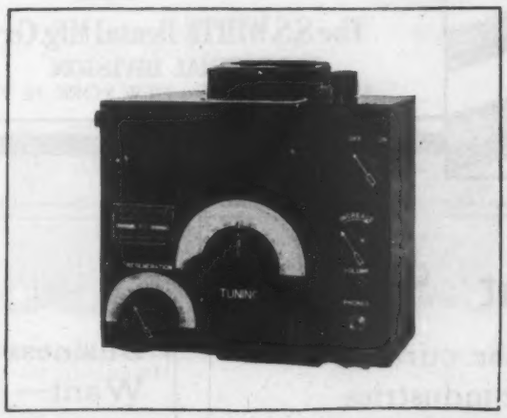
FLEETWINGS, INC.
ROOSEVELT FIELD
GARDEN CITY, NEW YORK

Dependability

RCA's two-way aircraft radio equipment is absolutely dependable. It works every time you press the button. Aside from its unerring dependability it is the lightest, simplest and most compact aircraft radio apparatus ever offered.



Type B Radiophone and telegraph transmitter for mounting anywhere in the ship to operate on any wave length between 30 and 900 meters. Weight 16 lbs., 6 ozs. Price $1,000 f.o.b., New York



Type A "All-Purpose" receiver is a thin local control unit for cockpit mounting. It provides Beacon-Weather, entertainment broadcast and short wave reception on voice or code. Weight 9 lbs., 8 ozs. Price $325 f.o.b., New York.

This combination radiophone and telegraph apparatus was designed for both transport and itinerant service and is especially recommended for use on planes which could not formerly carry voice communication equipment because of weight or space limitations.

Write for booklets describing the type of radio equipment used by Eastern Air Transport and Thompson Aeronautical Corporation.

Please address the nearest office,

Radiomarine Corporation of America

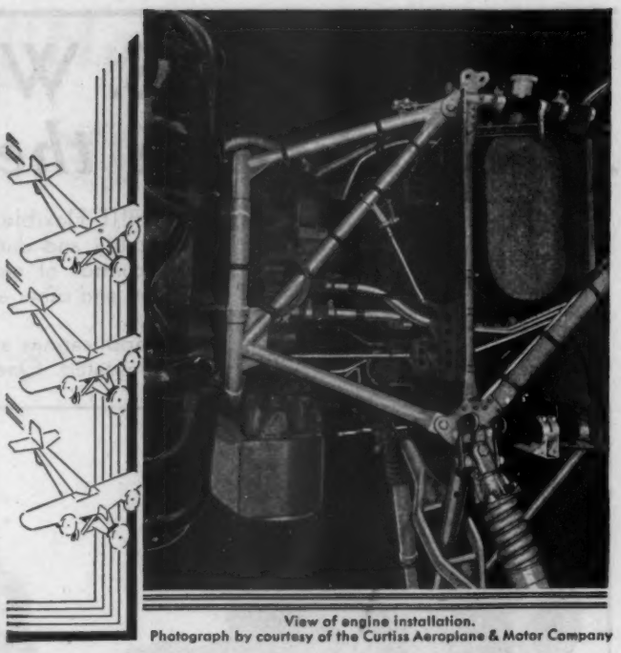
A Radio Corporation of America Subsidiary

66 Broad Street ∴ New York City

1599 St. Clair Ave., Cleveland, Ohio — **227 Fries Ave., Wilmington, Cal.** — **512-516 St. Peters St., New Orleans, La.**

16 First Street, San Francisco, Cal.

***Service Stations* at Boston, Baltimore, Norfolk, Savannah, Galveston, Chicago, Buffalo, Duluth, Seattle.**



View of engine installation.
Photograph by courtesy of the Curtiss Aeroplane & Motor Company

YOUR TUBING... ...PROBLEMS

LET US HELP TO SOLVE THEM

ENGINEERING and metallurgical experience and skill, modern equipment, expert workmanship that is only obtainable with *Shelby* master craftsmen. These advantages have long since placed the Ohio Seamless Tube Company in the van of competition as producer of the greatest variety of seamless steel tubing known to industry.

Because we can meet the exacting demands of the aviation industry . . . in either plain carbon or alloy steels that in some instances even exceed the rigid government specifications . . . we now supply the leading airplane manufacturers with part or all of the seamless steel tubing they use.

Avail yourself of our knowledge and experience. Our specialists will gladly help to solve any steel tubing problems that confront you.

The OHIO SEAMLESS TUBE CO.

COLD DRAWN SEAMLESS STEEL TUBING

Shelby, OHIO

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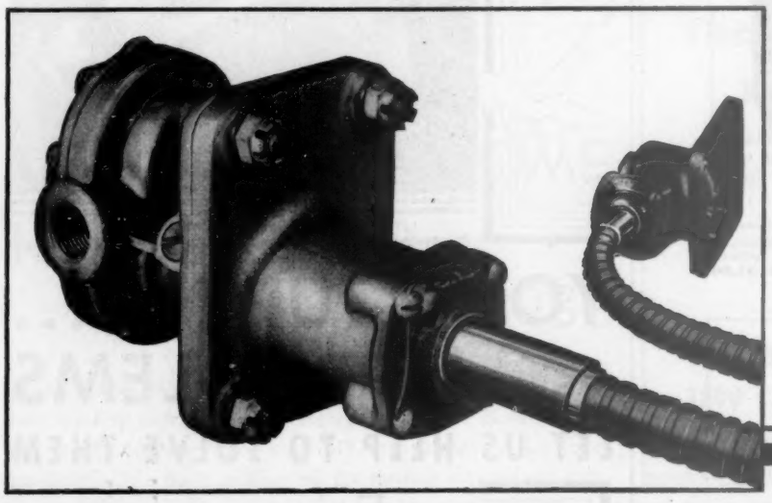
SOUTHWESTERN OFFICE: 2646-48 Washington Boulevard, St. Louis, Mo.

Another S. S. WHITE Flexible Shaft *Application in the Aviation Industry*

S. S. WHITE Flexible Shafts long ago earned a reputation in the Aviation Industry for reliability and durability in driving engine tachometers, in providing sensitive remote control of radio receivers, in operating gyroscopic stabilizers, magneto compasses and other aircraft equipment requiring a flexible element of transmission or control.

New applications are constantly appearing. One of the more recent is the fuel pump illustrated. One end of the shaft is connected to the pump and the other to the engine by means of the adapter shown. For applications of this character, where conditions preclude the use of a solid shaft, the self-contained flexible shaft unit is the simplest solution to the transmission problem.



S. S. WHITE Flexible Shaft applied to the Type C 5 Fuel Pump and Adapter manufactured by the National Steel Products Co.

Complete data on S. S. WHITE Flexible Shafts will be furnished on request. Engineering cooperation, bringing to bear the fruits of many years of manufacturing and applying flexible shafts, is also offered for the working out of specific applications. Address inquiries to

The S.S.WHITE Dental Mfg.Co.
INDUSTRIAL DIVISION
152-4 West 42nd St., NEW YORK, N. Y.

A Personal Want—

can invariably be filled by a friend.

The Searchlight Section

of this issue covers the current business wants of the industries in which this paper is read.

For Every Business Want
"Think SEARCHLIGHT *First"*

A Business Want—

must be satisfied by someone in your industry.

GN-029

Don't Run Your Engine To Heat Your Oil!

Reaches Any Part of the Oil Tank

Heat It Electrically

OUR Flexible Electric Immersion heating unit, adaptable to any type of tank, will heat the oil so that your ship is ready to take the air with only a few moments warming up even in the coldest weather and in a cold hangar.

This will save hundreds of dollars of expense and wear and tear on your engine. Write for full particulars at once. Start your saving immediately.

GENERAL STORAGE BATTERY CO., 2005 LOCUST ST., ST. LOUIS, MO.

ELECTRIC INSTRUMENTS COST LESS TO MAINTAIN

WHEN you compare instrument costs, be sure to consider maintenance. Remember that electric instruments require no tubing or shafting. They cost less to maintain.

Electric engine-temperature indicator (thermocouple type)

Electric tachometer

Electric pressure indicator (fuel or oil)

Electric temperature indicator for oil

General Electric also manufactures high-quality navigation instruments such as magneto and card compasses. Let us send you complete information. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

700-13

AËRONAUTIC EQUIPMENT

"Happy Landings . . YEAH!"

MANY'S the easy-going field mechanic who should have chucked the acid-pot out the window for good! A flying field is no place to use questionable "just solder" that needs a separate flux!

Speedy, safe repairing is vital. There's no time to hunt for a mislaid flux bottle. When $55,000.00 takes the air with a $1,000,000 cargo of human lives don't impose the hazard of cracking up through cheap inferior solder. Keep Kester on hand. The flux is there inside the solder. No mixing to do. Just apply heat. The airplane industry expects and demands high quality materials, so whether you're at the field . . . or a builder of plane parts . . . use Kester! Kester is made of the highest quality virgin tin and lead exceeding Class A specifications of the American Society for Testing Materials. Write our Industrial Development Department for help on any solder problem. **Kester Solder Co.** *Inc. 1899. Main Office & Plant,* 4263 Wrightwood Ave., Chicago, Ill. *Eastern Plant,* Newark, N. J. *Canada*—Kester Solder Co. of Canada, Ltd., Brantford, Ont.

KESTER
FLUX-CORE
SOLDER
Acid-Core · Paste-Core · Rosin-Core

1932
NATIONAL
AIRCRAFT SHOW

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DETROIT
APRIL 2nd TO 10th INCLUSIVE

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THE PROVING GROUND OF PUBLIC ACCEPTANCE

The National Aircraft Show held at the Detroit City Airport and Hangar is acknowledged as the world's leading aircraft exhibition. It is the aircraft manufacturer's greatest opportunity to exhibit and demonstrate his products to a public that evinces a definitely increasing interest and purchasing power in the aircraft field.

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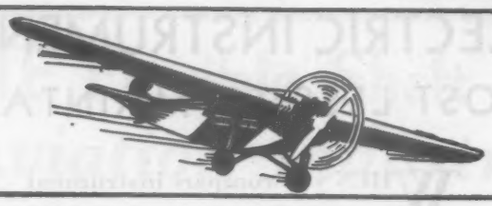

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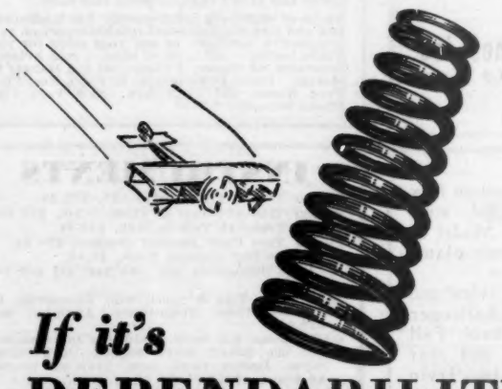

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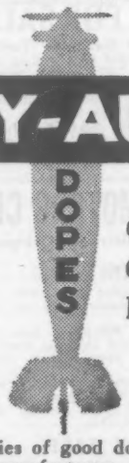

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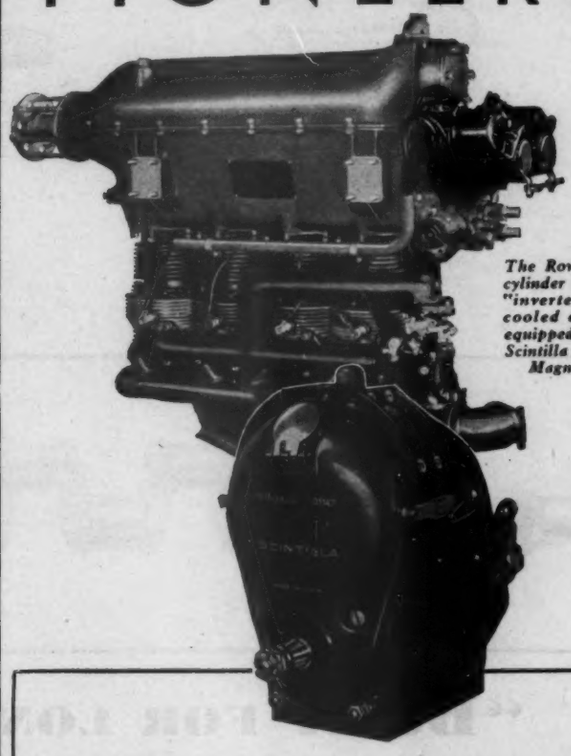

The Rover four cylinder in line "inverted" air-cooled engine, equipped with 2 Scintilla Aircraft Magnetos.

MICHIGAN AERO
and
SCINTILLA
AIRCRAFT MAGNETOS

The Michigan Aero-Engine Corporation, pioneer builders of inverted type engines, chose Scintilla Magnetos at the start —and still use them as standard equipment on all "Rover" engines.

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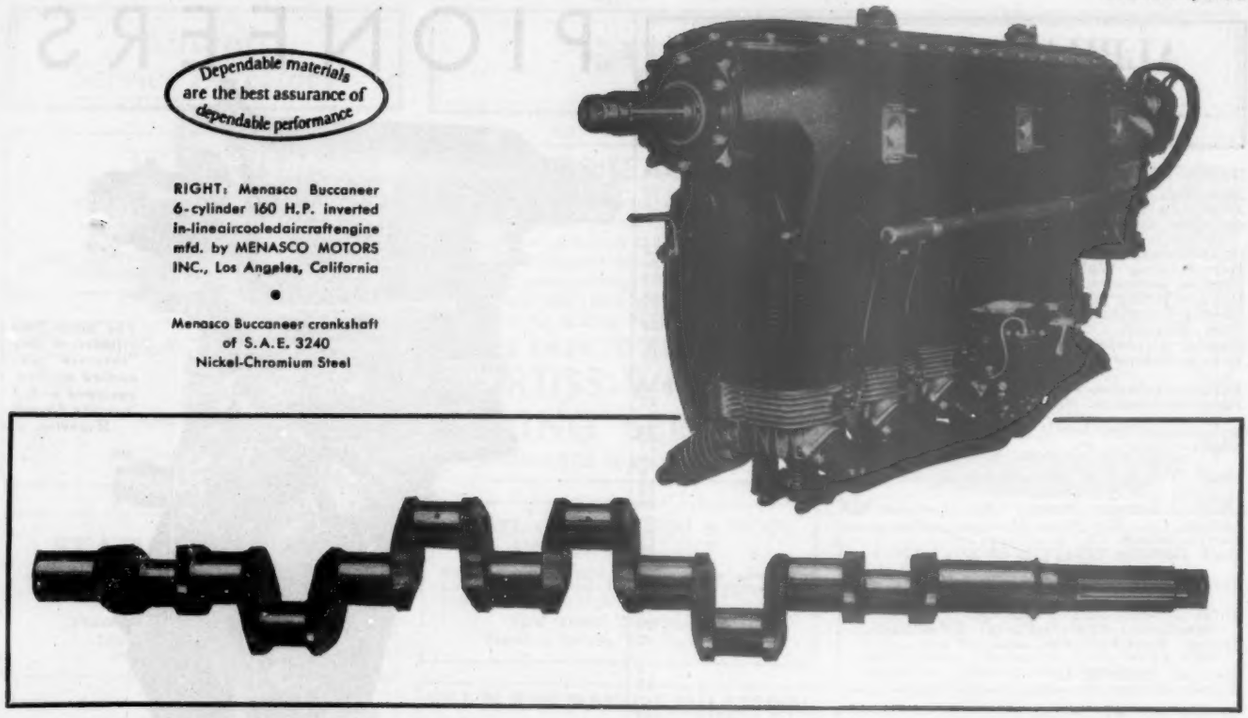
Dependable materials are the best assurance of dependable performance

RIGHT: Menasco Buccaneer 6-cylinder 160 H.P. inverted in-line aircooled aircraft engine mfd. by MENASCO MOTORS INC., Los Angeles, California

●

Menasco Buccaneer crankshaft of S.A.E. 3240 Nickel-Chromium Steel



"BUILT FOR LONG, USEFUL LIFE" with *Nickel Alloy Steel*, OF COURSE

● Aviation engineers have called the Menasco "Buccaneer" one of the smoothest running airplane engines made. Although comparatively new in design, this inverted six cylinder-in-line engine has been adopted by foreign governments for military use. It was a Buccaneer motor that powered the famous Northrop Beta plane which recently established new records for speed and economy.

"Menasco engines are built for long, useful life", say the manufacturers. That's another way of saying that these dependable engines have numerous Nickel Alloy Steel parts. The list of parts shown in the adjoining column indicates that Menasco engineers have built well with the alloy steels used by all leading airplane engine builders both in America and abroad.

For helpful assistance in selecting suitable Nickel Alloy Steels for aviation requirements consult our technical staff.

●

NICKEL ALLOY STEEL PARTS in Menasco Airplane Engines

S.A.E. 2315
Oil pump gears

S.A.E. 2330
All main bearing studs — Cylinder hold down studs
Engine support clamp bolt — Connecting rod bolt
Propeller hub bolts — Tappet adjusting locknut
Rocker bracket clamp bolt — All misc. studs
Misc. bolts, nuts and screws

S.A.E. 3240
Crankshaft

S.A.E. 3140
Magneto gear — Idler gear — Thrust bearing locknut
Idler shaft — Valve tappet — Oil pump drive shafts
Crankshaft gear — Oil pump driving bevel gear
Oil pump driven bevel gear — Camshaft gear
Tappet adjusting ball end

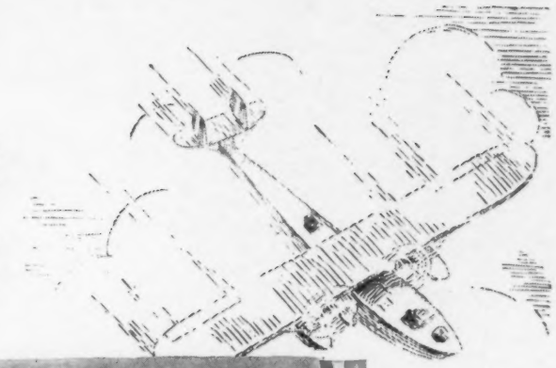
S.A.E. 3115
Valve tappet roller pins — Camshaft

Send for Bulletin No. 9, "Physical Properties of Nickel and Nickel-Chromium Steels".

Nickel
ALLOY STEEL
PERFORMS BETTER LONGER

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

VICTORY
in the Battle Against CORROSION

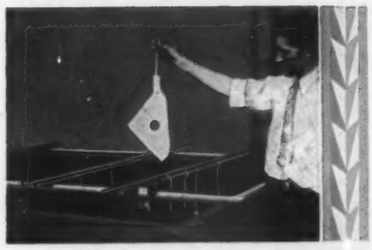


Anti-corrosion processes, developed by Martin, conquer destructive action of salt air and sea.

ACCURATELY controlled heat treating of aluminum alloys. Anodizing to coat the metal with a smooth, protective film which slightly absorbs and thus firmly holds bituminous paint. Spraying or rubbing *each separate part* with bituminous paint immediately after anodizing. Spraying with further special finishes after assembly. Covering with pure aluminum foil all parts in contact with wing fabric.

These are some of the anti-corrosion processes which are standard practice in the Martin plant. And these processes help explain why Martin all-metal planes are so thoroughly corrosion-proof, so economical to maintain.

Nowhere else in the industry will you find such highly developed anti-corrosion processes, and such extensive equipment for their use, as in the Martin plant. Nowhere else in the industry can aircraft of equal quality be produced in quantity at lower cost.



Above: "Not a sign of corrosion was found." That is what Naval inspectors reported after carefully inspecting Martin Seaplanes which had been in Southern waters with the Fleet for two years.

Left: The anodic film is deposited on all treated surfaces, protecting the inside of long tubes, and the corners, crevices and edges of irregularly shaped parts.

Above: To prevent corrosion at points where parts are joined, each individual part is given a separate coat of bituminous paint immediately after anodizing and before assembly.

Left: Special anti-corrosion finishes are applied after assembly. The large tunnel-type spray booths will accommodate even a completely assembled 100-foot hull.

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BALTIMORE, MARYLAND
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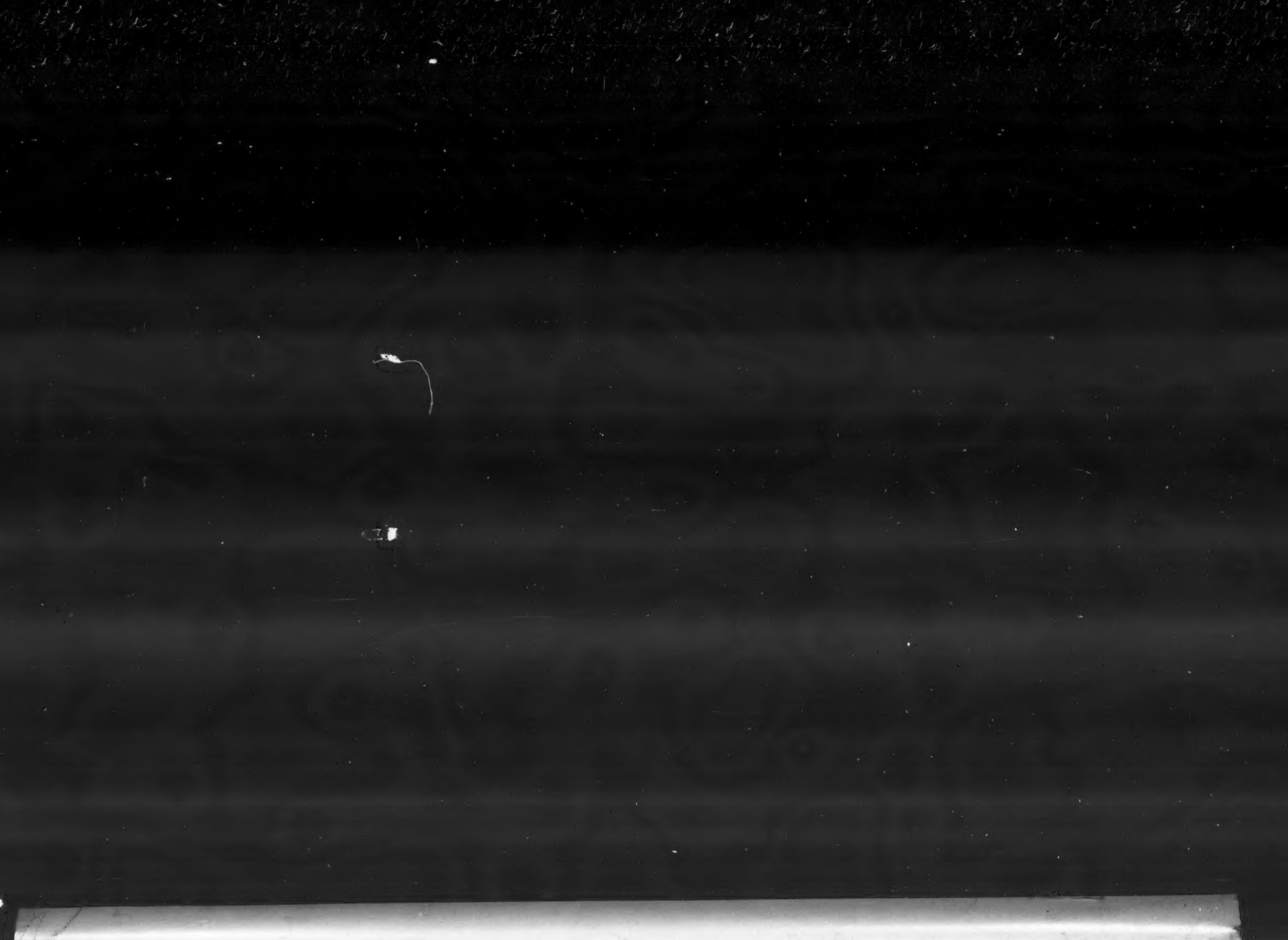
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